

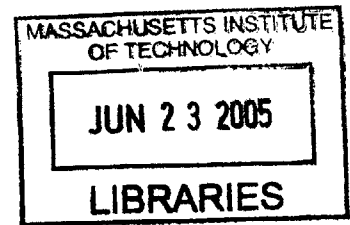
Application of Portfolio Theory to Labor Contract Valuation –  
The Case of the Airline Industry

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## **Abstract**

An analytic formula is derived in this thesis for the risk-adjusted financial value of a labor contract. The contract is modeled as a bond with a payment stream equivalent to the stipulated wages. The Capital Asset Pricing Model (CAPM) is used to determine the expected return from the bond relative to the entire financial market. The Net Present Value of the payment stream and the expected return of the bond are then combined to give the value of the labor contract. The resulting formula is a function of the contractual wage rate, the expected revenue of the firm, and the volatility of this revenue. This formula describes labor contract valuation for labor as a single group. The analysis is then extended to compare labor contract values among different labor groups within a single firm. Finally, a system dynamics model is utilized to study the impact of time delay between profitability and changes in pay. Analysis of the financial situation at nine US Major airlines reveals that in 2000, and in 2003, the wage rate at most of these airlines was higher than the optimal wage rate calculated by the model.





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## Table of Contents

Chapter 1: Introduction	13
1.1 Labor Contract Valuation	13
1.2 Key Questions	17
1.3 Structure of Thesis	18
Chapter 2: Background and Contributions	19
2.1 Previous Research: Determining the Value of Labor	19
2.1.1 Value of Labor Based on Psychology	
2.1.2 Value of Labor Based on Financial Analysis	
2.2 Different Approaches to Bankruptcy Prediction	24
2.3 Contributions	27
Chapter 3: Determining the Financial Value of a Labor Contract	29
3.1 Introduction	29
3.2 Extending the Framework of the Capital Asset Pricing Model to Calculate the Value of Labor Contracts	30
3.2.1 Assumptions	
3.2.2 Model Framework	
3.2.3 Extending the CAPM to Calculate the Value of a Labor Contract	
3.3 Value of a Labor Contract as a Function of Wage Rate	41
3.3.1 Normalized Value of Labor Contract Plot Along the <i>Wage Fraction</i> Scale	
3.3.2 Sensitivity Test Results	
3.3.3 Implication of the Shape of the Labor Contract Curve along the <i>Wage Fraction</i> Scale	
3.4 Comparison of Value of Labor Contracts between Employee Groups	54
3.4.1 <i>Adjusted Revenue</i> Distribution among Labor Groups	
3.5 Summary	61

Chapter 4: System Dynamics Modeling of the Impact of Dynamic Behavior	
on the Value of a Labor Contract_____	63
4.1 System Dynamics Model of Profitability and Employee Compensation	65
4.1.1 Model Requirements and Tool Selection	
4.1.2 The Salaries and Benefits System Dynamics Model	
4.2 System Response Testing	77
4.3 Results and Implications on the Value of Labor Contracts	86
Chapter 5: The Case of the US Airline Industry_____	91
5.1 US Airline Industry Background	92
5.1.1 Airline Profitability	
5.1.2 Labor Compensation	
5.1.3 Comparison of Labor Compensation between Different Airline Employee Groups	
5.1.4 Summary of Challenges Facing the Airline Industry	
5.2 Previous Work in the Area of Airline Labor Cost	102
5.2.1 Airline Labor Rent	
5.2.2 Effects of Regulation, and Explanation for Pay Premium under Regulation for the Airline Industry	
5.2.3 Effect of Deregulation: Predictions and Actual Impacts on Unionization and Labor Rent	
5.2.4 Discussion of Problems Facing the Industry	
5.3 Applying the Labor Contract Value Curve Analysis to the US Majors	112
5.3.1 Value of Labor Contracts in 2000	
5.3.2 Value of Labor Contract over Time	
5.4 Applying the Value of Labor Contract Comparison between Employee Groups to US Majors	123
5.4.1 Assume Value of Frictional Loss Fraction is Equal between Two Labor Groups	
5.4.2 Implied Value of Frictional-Loss Fraction for Labor Groups	

5.4.3	Summary of Comparison of Compensation between Employee Groups	
5.5	Post 9/11 Results	140
5.5.1	Wage Fraction and Labor Contract Values in 2003	
5.5.2	USAirways' 2nd Bankruptcy	
5.5.3	Difficulties in Adopting the Labor Contract Value Analysis to Real World Data	
5.6	Airline Industry Case Study Summary	148
Chapter 6:	Conclusion and Future Work	151
6.1	Conclusion	151
6.2	Suggestions for Future Work	158
	Bibliography	161
	Appendix	167

## List of Tables

4-1	Group 1 Simulation Input Parameters	77
4-2	Group 2 Simulation Input Parameters	78
4-3	Group 3 Simulation Input Parameters	78
4-4	Group 1 Simulation Input Parameters	79
4-5	Group 2 Simulation Input Parameters	81
4-6	Group 3 Simulation Input Parameters	83
5-1	Airline Employee Pay Premium by Hirsch & MacPherson	103
5-2	US Major Airlines in 2000	114
5-3	Pilot Wage Summary Table	125
5-4	Mechanics Wage Summary Table	126
5-5	Flight Attendant Wage Summary Table	127
5-6	Mechanics' Wage as a Percentage of Pilots' Wage Table	128
5-7	Flight Attendants' Wage as a Percentage of Pilots' Wage Table	129
5-8	Pilots' Wage Premium Summary Table	132
5-9	Mechanics' Wage Premium Summary Table	133
5-10	Flight Attendants' Wage Premium Summary Table	134
5-11	$\frac{\delta_{Mechanics}}{\delta_{Pilots}}$ Summary Table	136
5-12	$\frac{\delta_{FlightAttendants}}{\delta_{Pilots}}$ Summary Table	137
5-13	US Major airlines in 2003	141
5-14	<i>Adjusted Revenue / Capital Employed</i> , US Major airlines in 2003	146
5-15	<i>Adjusted Revenue / Capital Employed</i> , Hub & Spoke vs. Point-to-Point	147

## List of Figures

3-1	Applying the CAPM Technical Setting to Calculate Value of a Labor Contract	34
3-2	Normalized Labor Contract Value Curves (LCVCs) vs. Wage Fraction	43
3-3	Normalized LCVC vs. Wage Fraction, $\rho^*S_{mkt}=0$	45
3-4	Normalized LCVC vs. Wage Fraction, $\rho^*S_{mkt}=1.875$	45
3-5	The values of 1 <sup>st</sup> term: $\frac{w^*}{\mu} \cdot N_0$	48
3-6	The values of 2 <sup>nd</sup> term: $\frac{w^*}{\mu} \cdot \rho \cdot N_1 \cdot S_{mkt}$	49
3-7	The values of 2 <sup>nd</sup> term, Revenue Volatility $\sigma/\mu=0.1$	50
3-8	Breakdown of LCVC	51
4-1	The Salaries and Benefits Systems Dynamics Model	67
4-2	Calculation of Operating Profit Margin	69
4-3	Calculation of Total Operating Cost	69
4-4	Calculation of Employee Salaries + Benefits	70
4-5	Calculation of Employee Productivity	71
4-6	Calculation of S+B/Employee	71
4-7	Hypothesis linking % Change in Productivity to % Change in Pay	72
4-8	Hypothesis linking % Change in Pay to Operating Profit Margin	73
4-9	Balancing Loop	74
4-10	Reinforcing Loop	75
4-11	Operating Profit Margin with Increasing <i>Pay Increase Ratio</i>	79
4-12	Percent Change in Pay with Increasing <i>Pay Increase Ratio</i>	80
4-13	Percent Change in Productivity with Increasing <i>Pay Increase Ratio</i>	80
4-14	Operating Profit Margin with Increasing <i>Productivity Increase Ratio</i>	81
4-15	Percent Change in Pay with Increasing <i>Productivity Increase Ratio</i>	82
4-16	Percent Change in Productivity with Increasing <i>Productivity Increase Ratio</i>	83
4-17	Operating Profit Margin with Increasing <i>Pay Increase Delay</i>	84

4-18	Percent Change in Pay with Increasing <i>Pay Increase Delay</i>	85
4-19	Percent Change in Productivity with Increasing <i>Pay Increase Delay</i>	85
4-20	<i>Wage Fraction</i> Comparison, Increasing <i>Pay Increase Delay</i>	87
4-21	Value of the Labor Contract, Increasing <i>Pay Increase Delay</i>	88
4-22	Value of the Labor Contract, Increasing <i>Pay Increase Delay</i>	89
5-1	Quarterly Operating Profit Margin of US Major carriers between 1978 and 2003	94
5-2	Breakdown of Total Operating Costs, US Majors, 2001	96
5-3	Salaries and Benefits as a Percentage of Total Operating Costs	98
5-4	Constant Dollar, Unit Revenue vs. Labor Unit Cost	99
5-5	Employee Number Breakdown vs. Employee Salary Breakdown, Sum of US Majors, 2000	100
5-6	Top 5 US Major Airlines in 2000	115
5-7	Next 5 US Major Airlines in 2000	116
5-8	HP LCVC vs. WN LCVC	117
5-9	Value of Labor Contract for WN, 1989-2002	120
5-10	Value of Labor Contract for UA, 1989-2002	121
5-11	Pilots, Flight Attendants, and Mechanics Wage Comparison	127
5-12	Risk-Free Wage as a Percentage of Pilots' Risk-Free Wage	129
5-13	Pay Premium Comparison for US major airlines	135
5-14	Implied Frictional Loss Fraction Comparison for US major airlines	137
5-15	LCVCs for Top 5 US Major airlines in 2003	141
5-16	LCVCs for Next 3 US Major airlines in 2003	143
6-1	Normalized Labor Contract Value Curves (LCVCs) vs. Wage Fraction	154



## *CHAPTER 1*

# INTRODUCTION

### **1.1 Labor Contract Valuation**

Unions are often faced with a dilemma during contract negotiations with private industry. On the one hand, unions want a contract that provides members with the maximum pay to which management will agree. On the other hand, unions want the company to be profitable enough to ensure job growth and job stability. These two goals are in opposition. As the total amount of the contract increases, the profitability of a company is transferred to labor. At some point, the returns of the company become unattractive to investors, or the financial health of the company starts to suffer. In response, the company may have to seek wage concessions or lay off employees. Either outcome would reduce the market value of the signed contract. The market value of a labor contract may not be the same as the contractual (face) value if the company cannot afford to pay the contractual wage rate. In order to study the relationship between labor contract value and wage rate, a methodology is required to determine the value of the labor contract as a function of wage rate.

The valuation of a labor contract, as well as wage determination, has been studied from a wide array of theoretical and empirical perspectives. The oldest and most commonly used methodology for determining the value of a labor contract is the neoclassical microeconomic model of labor economics. The model of labor economics is very similar to the neoclassical microeconomic model of supply and demand. In the latter model, forces of supply and demand determine the equilibrium point for price and quantity. In

the case of labor economics, wage rate is analogous to price while the number of employed people is analogous to quantity.

In the neoclassical microeconomic model, consumers and producers are assumed to be rational as they seek to maximize their utility function. Perfect competition forces firms to act as price takers, and the resulting equilibrium price is the marginal revenue. For the neoclassical microeconomic model of labor economics, labor markets are considered to be perfectly competitive, and as a result, workers in the equilibrium condition earn their marginal product of labor.

The methodology of labor valuation using the neoclassical microeconomics model assumes an idealized setting of perfect competition as well as equilibrium between supply and demand. Thus, one could argue that this methodology falls short in two areas:

- 1) The neoclassical labor microeconomics model assumes perfect competition and presupposes a long-run supply and demand equilibrium point. In reality, an imbalance between supply and demand over the short run time horizon always exists. This leads to either labor surpluses or labor shortages. Labor surpluses result in increased unemployment while labor shortages often result in higher labor prices and labor rent.
- 2) The neoclassical labor microeconomics model assumes that employees negotiate individually with their employers. In reality, external factors, such as unionization and collective bargaining, can impact the resulting wage rate and quantity for employed labor.

Researchers recognize the limitations of the neoclassical model, particularly the fact that wage setting is a collective process in most settings, and so they have studied a variety of formal bargaining models. The most famous model in this area is John Nash's Nash Equilibrium model (1950), in which Nash proposes a set of equilibrium conditions for which no player in the game can benefit by changing their strategy if all other players maintain their strategy. Other examples include industrial relations models that explicitly model the relationships among wages, employment, productivity, and profitability.

Examples in this area include Dunlop (1957), and Ross (1970). Another very recent example is Gittell, Kochan, and von Nordenflycht (2003), in which researchers modeled labor relations in the airline industry.

In this thesis, an alternative approach is proposed. Instead of wage determination, a value is placed on a labor contract by using a version of portfolio theory. The main difference is that wage determination involves subjective factors such as negotiations, while valuation is a quantitative measure of the labor contract. This approach focuses on the fact that the profit of a company and the employee salaries are directly linked. An increase in employee salaries results in a decrease of the same amount in company profits. Assuming revenues are determined by external factors, and assuming all other costs are sunk cost, the division of fortune between salaries and profits has a direct effect on both labor and equity. As labor pay increases, the decline in profitability can lead to a need to ask for labor concessions, as the company inches closer to bankruptcy. In order to measure the effect of the company's financial state on the labor contract, the labor contract is assumed to be a tradable security. By treating it as a tradable security, a version of the portfolio theory could be extended to calculate the expected returns and inferred market value of the contract, taking into consideration the probability of bankruptcy for the company. Evaluating the labor contract as a tradable security also allows the labor contract to be calculated in a similar fashion as the stock of the company.

The word "value" has different meanings to different stakeholders, and it is important to discuss the exact meaning of labor contract "value" being discussed in this thesis. When a labor contract is signed, the "face value" of such a contract could be the net present value of the salary payout for the specified time period. In reality, if the company is forced into bankruptcy because it could not afford this labor contract, the actual salary payout may be somewhat less than the face value of the contract. In order to reflect this reduction in value, the term "market value" could be used to describe the adjusted value due to the probability of bankruptcy. The focus of this thesis is to use an extension to the portfolio theory model, in this case, the Capital Asset Pricing Model (CAPM), to

determine the market value of the labor contract. The market value of the labor contract could be very different from the face value of the labor contract.

The approach proposed in this thesis is to treat the labor contract as a tradable security. Since labor contracts specify payments on a fixed schedule similar to bond payments, a duplicating bond could be constructed to mimic the labor contract payments. Bonds have a face value as well as a market value. Based on the company's financial performance as well as correlation to the market, the market value of the bond would fluctuate from the face value. The value of the labor contract being calculated is then equal to the CAPM calculated market value of the duplicating bond.

One example of how this calculated labor contract value could be used is the following: a laborer has no assets other than a signed job contract. This laborer needs to take out a mortgage. Assume this laborer has no other expenses and is able to apply the full salary toward mortgage payments. Since this laborer works in a volatile industry, the bank knows that the laborer may not receive the full contractual pay. Therefore, when determining the maximum mortgage amount, the bank could use the CAPM calculated labor contract value as it takes into account the probability of bankruptcy as well as correlation with the overall market. The maximum amount the bank would be willing to loan would be the market value of the laborer's labor contract.

It is important to note that the approach taken here is not assumed to be "better" or preferred to existing theoretical and empirical approaches to studying wages, their determination, their valuation, or their interrelationships with other aspects of the employment contract, firm performance, or market outcomes. Rather, the purpose of this research is simply to illustrate how the CAPM might be applied to the valuation of labor contracts. The judgment as to whether this is a better approach is left to the reader.

## **1.2 Key Questions**

This thesis is structured to answer the following key questions:

- 1) How could a value be placed onto a labor contract as a function of wage rate?

The value of a tradable security is the net present value of its future earnings stream. Labor contracts are not tradable, so a market value is not readily available. When a contract is signed, it has a face value reflecting the contractual wage rate. However, in cases where the company is in financial distress and unable to pay the contractual rate, the market value of the labor contract will be less than its face value. A methodology is developed in this thesis to calculate the market value of the contract.

- 2) How does the value of the labor contract change with increasing wage rate?

Once the value of the labor contract can be determined as a function of wage rate, it is then possible to study the characteristics of labor contract value. Labor contract value has a maximum point as a function of wage rate; this is the point for which labor could receive maximum pay, after adjusting for the company's financial risk.

- 3) How could one compare the various labor contract values across different unions within the same company?

The labor contract values can be calculated for different unions. Standard techniques to compare different tradable securities can be applied to compare various labor contract values across different unions.

- 4) When the labor contract value is at its peak, how would the time delay between profit and changes in pay affect the value of the labor contract?

Contract valuation calculations provide a static value for the labor contract. Since there are typically time delays between profit and changes in pay, a system dynamics model is utilized to examine the impact of this time delay on the value of the labor contract over time.

A case study of the application of the proposed analysis for labor contract valuation is presented in the second part of this thesis. The industry chosen for the case study is the US airline industry. The majority of the US major airlines (abbreviated to "US Majors" in the rest of this thesis) are unionized, but they are facing increasing competition from non-unionized, start-up carriers with lower operating costs. The airline industry is one for which the application of the analysis presented in this thesis may be beneficial to various stakeholders.

### **1.3 Structure of Thesis**

The structure of this thesis is as follows:

#### **Chapter 2: Background and Contributions**

In Chapter 2, previous work related to bankruptcy prediction and valuation of labor contracts is discussed. Also, the contributions in this thesis are identified.

#### **Chapter 3: Determining the Value of a Labor Contract**

In Chapter 3, the Capital Asset Pricing Model (CAPM) is reviewed, and an explanation of how the model can be extended to determine the value of labor contracts is presented. A framework modeling labor contract value is also described in detail. Furthermore, a methodology to compare labor contract values across different unions is suggested. Finally, results as well as implications are discussed.

#### **Chapter 4: System Dynamics Modeling of the Impact of Dynamic Behavior on the Value of a Labor Contract**

In Chapter 4, a system dynamics model is presented in an attempt to answer the key question: “How could time delay between profit and changes in pay affect the value of the labor contract?” Then simulation results are used to discuss impacts of the delay as well as the benefits of reducing the said delay.

#### **Chapter 5: The Case of the US Airline Industry**

The analysis presented in Chapter 3 is applied to the US airline industry. These include labor contract valuation and comparison across labor unions.

#### **Chapter 6: Conclusions and Future Work**

In Chapter 6, findings of this thesis are summarized. This chapter also contains suggestions for future research related to determining the value of labor contracts.

## *CHAPTER 2*

# **BACKGROUND AND CONTRIBUTIONS**

The first step in developing an alternative methodology for labor contract valuation is to examine previous studies in the area of labor contract valuation.

The literature review was conducted using the resources at the MIT Libraries. The Virtual Electronics Resources Access (VERA) was the primary tool utilized in the search. The databases searched included EconLit, JSTOR, GPO, Dissertation Abstracts, LexisNexis, PAIS, ProQuest, and Transport. The literature review covers the area of economics (EconLit), doctoral dissertations (Dissertation Abstracts), news, business, statistical, and legal articles (LexisNexis), government and public affairs documents (GPO, PAIS), transportation / airline (Transport), and other comprehensive journal index databases (JSTOR, ProQuest). The listing of all relevant papers are presented in the bibliography appendix. In this chapter, a selection of the most relevant papers is presented.

### **2.1 Previous Research: Determining the Value of Labor**

A survey of previous research in the area of labor or labor contract valuation yielded two major approaches to determining the value of labor or labor contracts. The first approach is based on the field of psychology, while the second approach is based on financial analysis.

### **2.1.1 Value of Labor Based on Psychology**

There are two psychology papers in which authors used psychological methods to determine the relative value of labor. Rohrbaugh, McClelland, and Quinn (1980) wrote a paper titled: “Measuring the Relative Importance of Utilitarian and Egalitarian Values: A Study of Individual Differences about Fair Distribution”, and Stuhlmacher and Stevenson (1994) wrote a paper titled: “Predicting the Strength of Preference for Labor Contracts using Policy Modeling.”

Rohrbaugh, McClelland, and Quinn (1980) approached the question of the value of labor contracts by asking 102 graduate students to rate labor contracts with various attributes. The authors noted that among the responses from these graduate students, there were large differences in individual preferences in the relative importance placed between egalitarian and utilitarian principles. This suggests that individuals maybe have significantly different utility functions. The authors also tried to find links between individual preferences and the individual’s conservatism, religiosity, and dogmatism. The results showed that management on the whole seems to prefer high utility, while labor seems to prefer high equality.

Stuhlmacher and Stevenson (1994) approached the question of the valuation of labor contracts in the form of a policy model. Similar to Rohrbaugh, et al, Stuhlmacher and Stevenson also asked subjects to determine the value of labor contracts. Instead of asking subjects to rate contracts, however, the authors asked their subjects to rank the contracts. Specific contract variables that varied within the list of contracts include wage offered, job security, and profit sharing plans. The authors were able to construct a model that could assign a numerical value to each labor contract, according to the attributes. The authors then asked the original subjects to return and re-rank contracts, a pair at a time. The authors found that if the two contracts being compared have similar values calculated from the constructed model, the probability of subjects consistently correctly ranking them decreases.



The research in this thesis seeks to find the relationship between value of labor contracts and wage rate. In order to perform this analysis, there needs to be a consistent, repeatable measure of labor contract value. Approaches based on psychology have used human subjects to evaluate hypothetical contracts. Rohrbaugh, McClelland, and Quinn (1980) focused their research on the subjects' preference for equality versus utility. They did not provide a solution to assigning a value to the labor contracts. Stuhlmacher and Stevenson (1994) on the other hand were able to construct a model that could assign a numerical value to each contract. However, based on their results they were unable to consistently predict how a subject would rank the contracts. Furthermore, neither model provided a methodology to link contract valuation to company financial performance. Since there are other approaches more suitable for the research at hand, psychology-based models are not used.

### **2.1.2 Value of Labor Based on Financial Analysis**

The second approach to placing a value on a labor contract is based on financial analysis. Previous researchers have used financial models to analyze labor-related problems. An example of such is by Mahle (1987) titled "An Options Model of Employee-Firm Contracts (Seniority)."

Mahle (1987)'s research focused on determining the value, to senior workers, of seniority benefits. The financial model used was the Black and Scholes' Option Pricing Model (OPM). It was assumed that all employees have the same pay level but different levels of seniority. Mahle's work did not take into account for equity, and there was no interaction between the financial results of the firm, the pay level, and the value of the labor contract. This research cannot be extended to find the relationship between wage rate, financial success of the company, and the resulting labor contract value. However, this research does validate the approach of using financial tools to study labor problems.

The need for a consistent measure of labor contract value as well as linking profitability with pay, leads to the Capital Asset Pricing Model (CAPM). The CAPM will be

introduced in detail in Chapter 3. The CAPM has been applied to labor issues but in a different context. Neumann (1980) published a paper titled: “The Predictability of Strikes: Evidence from the Stock Market.” Neumann hypothesized that if the stock market accurately predicts strikes, then the difference between actual (stock market) and predicted (CAPM calculated) returns should have a mean value other than zero. Neumann demonstrated that this hypothesis was true, and concluded that strikes are predictable based on stock market returns. This research had one major deficiency -- the dataset used contained only companies that actually saw strikes. Neumann did not perform his experiment on companies that faced the threat of a strike but did not strike. His research used the CAPM to study a labor-related problem, but his problem was simplistic, and he did not consider the link between labor pay and company profitability. He also used the CAPM in the traditional way: to calculate stock returns.

Another paper that applied the CAPM to labor problems is Dreze (1989), titled: “The Role of Securities and Labour Contracts in the Optimal Allocation of Risk-Bearing.” Dreze’s paper extends the CAPM to production from labor inputs in an attempt to link labor contracts with securities. Labor contracts, specifying hours and wages in each instance, permit the sharing of risk between workers and equity owners. In his model, however, the CAPM risk distribution is focused on individual employee wealth, not on the probability of a company’s bankruptcy.

Dreze’s paper is similar to this paper in that it acknowledges the risk-sharing element between labor and equity, and therefore the selection of CAPM as the financial tool is also similar. However, similar to research done by others, Dreze applied the CAPM in the traditional way: to the calculation to equity. Dreze’s approach to labor valuation is similar to the neoclassical model, in which individual employees bargain and achieve their own efficient point with the employer. In his paper, individual contracts are different, and risk sharing with the company is based on the individual’s wealth and risk aversion levels. Dreze’s paper uses similar tools to the ones proposed in this paper, but his assumptions are different from the one here, and his application of the financial tool is also different.

Finally, McGoun (2003) discussed the application of finance models in his paper titled: “Finance Models as Metaphors.” McGoun noted that financial models such as the CAPM and the Black and Scholes Option Pricing Model (OPM) are quantitative models that cannot be applied literally, but do provide figurative knowledge as well as a “useful framework.” He went on to discuss how the OPM has been extended to study real world problems, called “real options”. The discussions about OPM and real options serve as a motivation to extend the CAPM to the real-world labor contract valuation problem, similar to how the OPM could be extended to study real options.

To conclude, recall from Chapter 1 that the goal of this thesis is to propose an alternative approach to labor valuation. The key question this researcher attempts to answer is how to place a value onto a labor contract as a function of wage rate. Previous researchers have used the CAPM to study labor-related problems. Previous researchers have also acknowledged that the wage rate and the financial success of a company are linked. However, no one has treated labor as a stakeholder similar to equity, considered the closely coupled nature of labor and equity, or used the CAPM to derive a labor contract valuation. The lack of previous research bridging the missing link is probably due to the fact that the CAPM was originally developed to evaluate stock returns of a company, and previous researchers have therefore simply applied the CAPM to calculate firm returns when studying labor related problems. This research will be the first to treat labor contracts as tradable securities. This research will also be the first to apply CAPM derived formulas to calculate the implied value of the labor contracts.

Furthermore, all labor related models mentioned here are one-period static models; there were no consideration of dynamics and interaction of various factors. In Chapter 4, a system dynamics model will be used to study the dynamics of the model.

## 2.2 Different Approaches to Bankruptcy Prediction

In order to study the market value of a labor contract, a scientific, consistent method of determining the probability of bankruptcy is required. In this section, a review of bankruptcy prediction models is presented, and the selection of portfolio theory is discussed.

Determination of the financial health of a company, whether in the form of bankruptcy prediction or credit risk quantification, has been viewed as an art rather than a science. (Kealhofer, 2003) There are three types of commonly used methods to determine financial health or bankruptcy risk of a firm. These are:

1. Managerial performance models

This is a subjective model, based on the analyst's judgment in relation to the overall managerial, financial, and trading position of the firm. Analysts assign scores under 3 major headings – defects, major mistakes, and symptoms. The scores are given based on a point system. Similar to problems with psychology-based approach described in the previous section, the results from managerial performance models are subjective, and is not suitable for this research.

2. Univariate financial ratio analysis

This approach analyzes a firm's financial ratios both on a cross-sectional basis and on a time-series basis. Ratios commonly used include profitability ratios, leverage ratios, activity ratios, and investment ratios. All these ratios for a firm are calculated, and the analyst needs to examine each ratio separately. This method relies on the analyst's interpretation of the ratio, so this method is subjective. Furthermore, it is possible that the ratios could indicate contradictory results. Again, the subjective nature of the univariate financial ratio analysis makes it not suitable for this research.

3. Multiple discriminant analysis (MDA)

Altman developed the MDA in response to shortcomings of the univariate financial ratio analysis. Altman initially developed the general MDA model,

and other researches have developed industry-specific models using the same methodology. They all follow the same steps:

- a) establish two mutually exclusive groups, namely those firms which have failed and those which are still continuing to trade successfully
- b) collect financial ratios for both of these groups
- c) identify the financial ratios which best discriminate between the two groups
- d) establish z-score based on these ratios

The main advantage of MDA over univariate financial ratio analysis is that MDA is based on objective statistical data rather than on the financial analysts' subjective interpretation. The calculation of the z-score requires the following: 1) a number of ratios relevant to the operations and financial performance of an industry or company is selected, and 2) run a regression technique called multiple discriminate analysis to select which ratios to use and generate coefficients, based on the data above, and 3) the resulting z-score for companies are then measured against a scale of safe, middle ground, and danger area, to determine if a company is in danger of going bankrupt. The boundaries separating the three regions is determined based on historical bankruptcy data.

The most commonly used MDA model is the Altman Multiple Discriminant Analysis (MDA) z-score model (Altman, 1968). Gritta (1982) applied Altman's model to the airline industry and correctly predicted Braniff's bankruptcy. Based on Altman's methodology, Chow, Gritta, and Leung (1991) developed the first industry specific bankruptcy prediction model for the airline industry, called the AIRSCORE model.

Even though the Altman z-score model improves upon the other two models, it still has some shortcomings. One of the shortcomings is that the selection of financial ratios to include in the regression may be arbitrary and inconsistent. Another shortcoming is that the regression results could always be improved upon by including more financial ratios. As a result, two different researchers may decide to include or use different financial

ratios. MDA z-score models have the shortcomings of any regression-based models. In conclusion, although the MDA z-score model and its derivative models are capable of successfully predicting company bankruptcies, it is not suitable for this research.

Since regression-based models have some shortcomings, it was decided that the model for labor contract valuation should be derived from a first-principles model. One reason for using a scientific, first-principles model of bankruptcy prediction in the calculation of labor contract value is that unlike stocks, there is no database of labor contract market values to run the regression on. This is because labor contracts are not tradable. Without market value data for labor contracts, even though regression-based methods might be able to predict bankruptcy, it will not help in explaining how it might affect the value of the labor contract.

There are several first-principles models, including the Black-Scholes-Merton approach (Kealhofer, 2003), the KMV model (Kealhofer, 2003), and the Capital Asset Pricing Model (CAPM) (Bodie, Kane, & Marcus, 4<sup>th</sup> Edition). According to Kealhofer (2003), the use of first-principles model in quantifying credit risk and default prediction has only recently been developed. Among the models mentioned above, the CAPM is the fundamental model, while the other models are extensions of it. Since the CAPM is the most basic and the most fundamental model, it is selected for the analysis of bankruptcy probability in the calculation of labor contract valuation.

With additional assumptions and extensions, the CAPM could be used to determine the probability of bankruptcy/liquidation. The CAPM assumes that one could always receive a risk-free return, and if the returns of a company is lower than the risk-free return, the company could liquidate and invest the proceeds in the risk-free asset. Note that the CAPM does not distinguish between liquidation and bankruptcy. As the returns of a company decreases toward the risk-free return, its probability of liquidation increases. Probability of liquidation from this model will be used to adjust the market value of the labor contract. This model is based on first-principles, and no historical data or

regressions are needed to calibrate the model. This model provides an objective, consistent measure for the probability of failure.

As noted in the earlier section, other researches have used financial models, including the CAPM, to study labor values. However, most researchers have used different tools to study problems different from the one proposed here. For those that used the CAPM, they have all applied the CAPM in the tradition way – to estimate stock returns. This research is the first to treat a labor contract as a tradable asset, and apply the CAPM to the labor contract that is traditionally a non-tradable object.

## **2.3 Contributions**

Based on the approach proposed in Chapter 1 and on the survey of prior research presented above, the identified contributions of this thesis are:

Contribution 1: The modeling of labor contracts as tradable securities, and the extension of the Capital Asset Pricing Model (CAPM) to establish valuation of labor contracts, as a function of wage rate.

The main contribution of this thesis is to model labor contracts as tradable securities, and to extend the Capital Asset Pricing Model to determine the market value of labor contracts. The Capital Asset Pricing Model is a popular model used to calculate the returns of various market securities. Previous works to gauge the value of labor contracts have used methods such as evaluating or ranking by human subjects. Value for labor contracts measured in this manner is subjective and may be inconsistent. Previous works have also used financial tools, including the CAPM, to analyze labor related problems. However, previous researches have either studied other problems than the one raised here, or applied the CAPM in the traditional way to calculate stock returns. The novel element of this research is that by treating labor contracts as tradable securities and extending the CAPM model, it is possible to calculate a measure that consistently and

quantitatively expresses the value of labor contracts, as a function of wage rate. The derivations will be presented in Chapter 3.

Once the main contribution is accomplished, the model proposed here could be applied to perform further analysis. The following three contributions will be the result from further analysis.

Contribution 2: Study how the value of the labor contract change with increasing wage rate

Another contribution is to apply the above model to study how the value of the labor contract varies over a range of wage rates. Calculations here could also serve to educate both management and union members the fact that a higher wage rate does not always lead to a more valuable contract.

Contribution 3: Analyze the revenue distribution among labor groups

Following the idea of treating labor contracts as tradable securities, it is possible to compare labor contracts of different labor groups as different securities. Standard financial tools such as the Sharpe Ratio can then be used to make such a comparison.

Contribution 4: Use of system dynamics modeling to study the impact of dynamic behavior on value of labor contracts

In Chapter 4 of this thesis, a system dynamics model will be used to study the impact of delays between profit and pay (longer contract duration, longer negotiations, etc.) on the value of labor contracts. The proposed contribution is to use system dynamics simulation results to proof that shortening delay could be beneficial to the value of labor contracts.



## CHAPTER 3

# DETERMINING THE VALUE OF A LABOR CONTRACT

### 3.1 Introduction

The methodology presented in this chapter has been developed to answer the following questions:

- 1) How could a value be placed onto a labor contract as a function of wage rate?
- 2) What implications are there concerning the value of the labor contract as wage rate increases past optimum rate?
- 3) How could one compare the various labor contract values across different unions within the same company?

The basis of this methodology is the Capital Asset Pricing Model (CAPM). The novel aspect of the methodology is that, rather than applying the CAPM to a stock, it is instead applied to the calculation of the labor contract value. In order to perform such a calculation, the labor contract is treated as a tradable security similar to the company's stock.

A key feature of the methodology is that the interrelationship between the fortunes of labor and ownership is explicitly modeled. That is, the model incorporates the effect that increasing wage demands have on airline profitability and thus the probability of insolvency. As labor receives a larger wage payment, owners see a smaller return on

their investment, resulting in a higher probability that they will decide to liquidate their financial position and invest their capital elsewhere. A higher probability of liquidation would lead to lower value for the labor contract, even though the contractual payment may be higher. The value of a labor contract is affected by the probability that there may not be an airline to work for. With CAPM-derived calculations, expressing the value of a labor contract as a function of wage rate, as well as revenue premium division between labor and ownership, is possible. It is also possible to calculate the optimum wage rate and revenue division to achieve maximum value for the labor contract.

A discussion of the methodology is presented in the remainder of this chapter. The Capital Asset Pricing Model, its assumptions, and the methodology applied from the CAPM to calculate value of labor contracts are introduced in Section 3.2. In Section 3.3, the results of the model are presented, sensitivity testing of the parameters is performed, and the implications of the shape of the Labor Contract Value Curve (LCVC) are discussed. In Section 3.4, an analysis of labor contract comparison between different labor groups within a company is presented. A CAPM related financial tool, the Sharpe Ratio, is used to perform the analysis. Finally, this chapter is summarized in Section 3.5.

It is important to note that the model presented here is derived from the CAPM. As suggested in McGoun (2003), even though the CAPM is a quantitative model, it is best thought of as metaphors, and the results cannot and should not be applied literally. Like most economic models, it is best to use the results as a way to explain trends. The model is simplified to capture the important elements, so the model does not serve to emulate every minute detail of the real world. The model should serve as a good framework, but the quantitative results calculated here are not meant to replicate the real world.

### **3.2 Extending the Framework of the Capital Asset Pricing Model to Calculate the Value of Labor Contracts**

The Capital Asset Pricing Model, commonly referred to as CAPM, is a widely used financial model developed by Dr. William F. Sharpe between 1963 and 1964. In 1990,

Dr. Sharpe was awarded the Nobel Memorial Prize in Economic Sciences for his role in the development of the CAPM (Burton, 1998; McGoun, 2003). The traditional application of CAPM is to calculate the estimated return of a portfolio relative to the risk-free return as a function of the parameter  $\beta$ . The parameter  $\beta$  is the covariance between the return of the portfolio and the return of the entire market, divided by the variance of the return of the market.

The CAPM methodology will be extended here to calculate a quantitative value for a labor contract. It will be applied in a non-traditional way: instead of estimating portfolio returns, labor contracts will be replicated into a tradable security, and the CAPM methodology will be to calculate the inferred value of this replicating security. The inferred value of this security is then the CAPM-inferred value of the labor contract. Treating labor contracts as tradable securities allows the labor contract to be compared to equity.

Three important aspects of this novel application are discussed in this section. In 3.2.1, the assumptions of the CAPM and the applicability of these assumptions to labor contract value estimations are discussed. In 3.2.2, the rationale of isolating labor wages and operating profits as well as the option framework for owners and labor are presented. Finally, in 3.3.3, the mathematical formulations for applying CAPM to calculate value of the labor contract are discussed.

### **3.2.1 Assumptions**

In this section, the CAPM assumptions are listed, and their applicability to valuing the labor contracts is discussed. Together these assumptions construct the “CAPM world.”

The CAPM was developed for “a frictionless one-period, multi-asset economy with no asymmetric information.” Specifically, the following seven assumptions are implicit in the CAPM (Bodie, Kane, and Marcus, Fourth Edition, 1999; Goetzmann, First Edition):

1. Investors are risk-averse individuals who maximize the expected utility of their end-of-period wealth.

The implication of this assumption is that CAPM is a one-period model, and the goal of every investor is to maximize his expected utility at the end of the time period. This goal is the same for labor, as they too want to maximize their expected utility at the end of the contract period. Thus, the application of the CAPM to calculate the value of the labor contract is valid.

2. Investors have homogenous expectations about asset returns.

The implication of this assumption is that all investors perceive identical opportunity sets, and everyone has the same information at the same time. By allowing owners and labor groups to have the same information regarding expected revenue and revenue variance, this assumption holds true.

3. All investors are rational mean-variance optimizers.

The novel aspect of this research is treating labor contracts as tradable securities. There is no modification to investor behavior. Therefore, this assumption holds true.

4. There exists a risk-free asset, and investors may borrow or lend unlimited amounts of this asset at a constant rate, which is the risk-free rate.

For calculating the value of a labor contract, the same assumption is used. Both ownership and labor are able to receive their respective risk-free asset. The owners are assumed to be able to receive risk-free return if they choose to purchase US Treasury Bills. Labor groups are also assumed to be able to find risk-free jobs with risk-free salaries. The selection of risk-free jobs and risk-free salaries will be covered in more detail later in this and the next chapters.

5. The number of assets is definite, and their quantities are fixed for the period being considered.

The limitation on the number of assets does not appear to impact the calculation of labor contract value. This assumption remains in place.

6. All assets are perfectly divisible and priced in a perfectly competitive market.

This assumption implies that the model is a continuous model as opposed to a discrete model, and that the usual assumption of perfect competition from microeconomics applies. These assumptions remain in place for the calculation of labor contract value.

7. Asset markets are frictionless, and information is costless and simultaneously available to all investors. There are also no market imperfections such as taxes, regulations, or restrictions on short selling.

Economic models usually are simplified high-level models that capture the underlying forces and trends. They are not designed to replicate the real world exactly, and the CAPM is no exception. Sharpe stated that after the initial CAPM model was developed, he experimented with adding more realism such as adding taxes. His finding was that the addition of such complexity does not improve the results from the most simplified CAPM model. Therefore, in this research, the most basic form of the CAPM model is utilized.

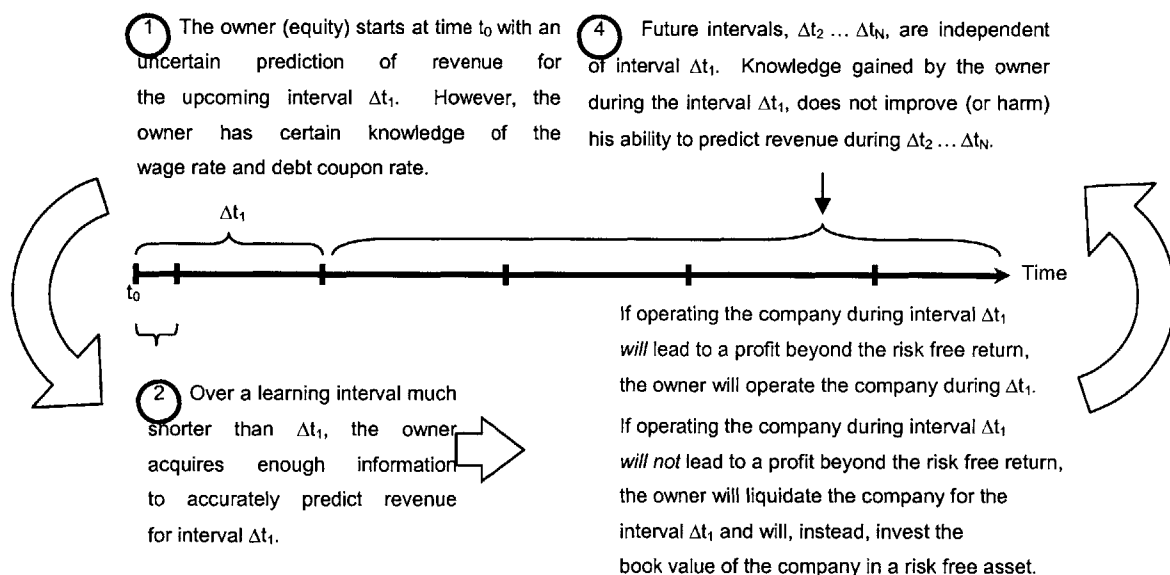
In summary, all of the assumptions for the CAPM apply when calculating the value of labor contracts. Again, it is important to emphasize that this model should be viewed as a useful framework. Assumptions were made to simplify the model and to allow the model to capture the most essential results. The research presented here does not model all the details required to duplicate the real world.

### **3.2.2 Model Framework**

The next step is to discuss the model framework as set forth by the assumptions above.

Figure 3-1 is a graphical representation of applying the CAPM framework to the calculation of the value of a labor contract. As described in the illustration, there are four steps involved:

1. At the beginning of the period,  $t_0$ , owners have certain knowledge of the expected revenue, variation in revenue, labor wage rate, as well as other cost information such as the debt coupon rate. Because the CAPM setting is a frictionless setting and information is costless and simultaneously available to all investors, labor has the same information as ownership.



**Figure 3-1: Applying the CAPM Technical Setting to Calculate Value of a Labor Contract**

2. Once the period starts, additional information is available regarding revenue for this period.
3. Once owners have knowledge of the revenue and cost for the time period, they then make the decision of whether to continue operating the company or to liquidate the company. Their decision is based on the following rules: if operating the company during this time interval will lead to a profit beyond the risk-free return, the owner will operate the company. However, if operating the company during the time interval will not lead to a profit beyond the risk-free

return, the owner will liquidate the company. Because the CAPM assumes that there is no frictional loss, owners will be able to invest the book value of the company in the risk-free asset and receive the risk-free return.

4. Because the model is a one-period model, all future periods are assumed to be independent of each other. Thus, no limits are set regarding the length of each time period. Additionally, because the CAPM assumes that all investors attempt to maximize their utility at the end of the time period, this time period could be considered the investment time horizon.

This framework makes two assumptions specific to the calculation of the value of labor contracts. The first assumption is that owners are the only stakeholders in the model that could decide on operation or liquidation. This decision is solely based on whether the company will achieve a higher than risk-free return for the owners. The value of the labor contract is partially influenced by the probability that the owner may decide to liquidate. The second assumption is that this probability is assumed to be normally distributed.

Since the focus of this research is on labor pay, company profitability, and the interrelationship between these two, all other cost will be considered sunk cost. Total operating revenue for the company will be used to pay sunk cost first. The remaining revenue will be the revenue base for labor and owner. From this remaining revenue base, risk-free investment return for the owner and risk-free wage for labor will be subtracted. The final remaining revenue is called “*adjusted revenue*.” The expected value for “*adjusted revenue*” per time period is called  $\mu$ . In essence,  $\mu$  is the expected value of sum of labor wage premium and owner investment return premium for the time period, and is expressed in units of dollars per unit time period (\$/time).  $\mu = E\{(\text{labor wage premium per time period}) + (\text{owner investment return premium per time period})\}$ .

To simplify the model, there will be only one owner and only one labor group. There will also only be one contract during the time period. All employee salaries are determined by this contract. It is further assumed that labor receives compensation only in the form of salaries. Other forms of payment such as stock ownership are not considered.

The risk-free investment return for owners is the government issued ten-year treasury rate. Currently, the ten-year instrument is the longest of the US government issues, and the risk of the US government declaring bankruptcy is miniscule. As for labor, the risk-free wage rate is the average salary of the entire working population of the United States, as published by the Bureau of Labor Statistics. It is assumed that the make-up of the labor group is similar to the average of the US working population, and therefore in case the labor group has to find alternative employment, the group members can receive the average wage of the population.

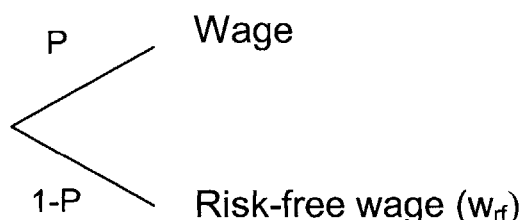
One may question the assumption that the owner will decide to liquidate the company when the return is less than risk-free return. It is a valid question, as there are many companies that showed poor profitability but do not liquidate or file for bankruptcy protection. The answer to this question is that the CAPM assumes that investors are rational, and they seek to maximize end-of-period wealth. Even though a company may be facing short-term losses, the losses over a longer period of time could be balanced out by periods of profitability. This model does not specify the length of the time period; if the time period is assumed to be long, then it may be possible that the owner expects the company to eventually achieve higher than risk-free returns. Another factor is the assumption that investors are rational. If a company historically achieved poor profitability, rational investors would not invest in such a company. However, history has shown examples of investors willing to invest in poorly performing companies such as airlines only to prolong the inevitable demise. This research decides to stay with the CAPM assumptions, and the psychology of investing in historically poor performing companies shall be left for another study.



Finally, the following options are made for labor in this model:

- If the owner decides to operate, then labor receives the contractual wage rate. The probability of the owner deciding to operate is  $P$ .
- If the owner decides to liquidate, then labor is forced to take the risk-free job and receive the risk-free wage rate. The probability of the owner deciding to liquidate is  $(1 - P)$ .

The payout function for labor is then:



$$\Pi = w_{rf} + w$$

where  $w$  is a step function with magnitude 0 if the owner decide to liquidate, and the magnitude equal to the wage level if the owner decide to operate.

### 3.2.3 Extending the CAPM to Calculate the Value of a Labor Contract

The Capital Asset Pricing Model is formulated as: (Investments by Bodie, Kane, and Marcus, Fourth Edition, 1999)

$$E[r] = r_{rf} + \beta \cdot (E[r_{mkt}] - r_{rf})$$

where:

$E[r]$  = Expected return on investment

$E[r_{mkt}]$  = Expected market return

$r_{rf}$  = risk-free rate of return

$$\beta = \frac{\text{cov}[r, r_{mkt}]}{\text{var}[r_{mkt}]}$$

Recall that the CAPM assumes there is a risk-free asset with risk-free return. The CAPM formula states that the expected return of an investment is equal to the risk-free return, plus a factor,  $\beta$ , multiplied by the return premium of the market. The  $\beta$  factor is unique

for each asset investment and is the covariance between the investment and the market, divided by the variance of the market. If the value for  $\beta$  is calculated, then calculating  $E[r]$ , the Expected return on investment, is possible by applying this CAPM formula.

While labor contracts are not traded explicitly, Dr. Sharpe stated, “Even in a market in which atomic securities are not traded explicitly, it is possible to create them synthetically....” and “Any desired set of payments can be replicated with a suitably chosen portfolio of existing securities.” (Sharpe, Website textbook) Because labor receives a steady stream of payments in the form of salaries and benefits based on their contract, calculating the value of such a labor contract is possible by creating a fictional security. Such a fictional security would receive payments equal to the amount of the labor salaries and benefits, thus replicating the payments for the labor contract. By calculating the value of this fictional security using the standard CAPM formulation, the corresponding value for the labor contract is also calculated.

The result of the calculations from the CAPM is the expected return for a security or an asset. Once the amount of the payout and the calculated expected return is known, calculating the inferred value for the security is possible using the following formula:

$$E[r] = \frac{E[\Pi]}{V}$$

where:

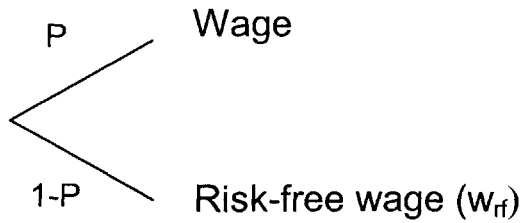
$E[\Pi]$  = Expected payout

$V$  = Implied value of the security

To calculate  $V$ , the implied value of the security, simply calculate  $\beta$  to get  $E[r]$ .

Applying the methodology described above to calculate the value of a labor contract results in the following:

The payout structure for labor is:



$$\Pi = w_{rf} + w$$

$$E[r] = \frac{E[\Pi]}{L} = \frac{w_{rf}}{L} + \frac{E[w]}{L}$$

In the case for the value of labor contracts,  $V$ , the value of the fictional replicating security, is equal to  $L$ , the value of the labor contract.

To calculate  $\beta$ , let the return of the labor contract be  $r$ .

$$r = \frac{\Pi}{L} = \frac{1}{L}(w_{rf} + w)$$

Let  $r_{mkt} = y$ , then:

$$\begin{aligned} \beta &= \frac{\text{cov}(r, r_{mkt})}{\text{var}(r_{mkt})} = \frac{\text{cov}(\frac{\Pi}{L}, y)}{\text{var}(y)} = \frac{1}{L} \frac{\text{cov}(\Pi, y)}{\text{var}(y)} \\ &= \frac{1}{L} \frac{E[(w_{rf} + w - w_{rf} - E[w]) \cdot (y - \bar{y})]}{\text{var}(y)} \\ &= \frac{1}{L} \frac{E[(w - E[w]) \cdot (y - \bar{y})]}{\sigma_y^2} \end{aligned}$$

Substitute  $E[r]$  and  $\beta$  into the CAPM formulation, multiply both sides by  $L$  and re-order the terms:

$$(L - \frac{w_{rf}}{r_{rf}}) \cdot r_{rf} = E[w] - \frac{E[(w - E[w]) \cdot (y - \bar{y})]}{\sigma_y^2} \cdot (\bar{y} - r_{rf})$$

Let  $L_{rf} = \frac{w_{rf}}{r_{rf}}$ , and calculate the expected values:

$$\therefore (L - L_{rf}) \cdot r_{rf} = w^* \cdot [N_0 + \rho \cdot N_1 \cdot S_{mkt}]$$

where:

$S_{mkt}$  is the Sharpe ratio of the market

$N_0$  is the normal probability distribution

$N_1$  is the 1st moment of *adjusted revenue* distribution

$\sigma_x$  is the standard deviation of *adjusted revenue*

$w^*$  is the wage level

$\rho$  is the correlation between market returns and *adjusted revenue*

$(L - L_{rf})$  is the implied value of labor contract premium (over risk-free value)

Alternative forms for this formula are:

$$(L - L_{rf}) \cdot r_{rf} = w^* \cdot N_0 + w^* \cdot \rho \cdot N_1 \cdot S_{mkt}$$

or

$$(L - L_{rf}) = \frac{w^* \cdot N_0 + w^* \cdot \rho \cdot N_1 \cdot S_{mkt}}{r_{rf}}$$

This formulation can be used to calculate the value of a labor contract premium over risk-free wage. A more detailed mathematical derivation, especially the steps required in deriving  $\beta$ , can be found in Appendix I. In the next section, the formulation derived here will be applied to the calculations of the value of a labor contract.

### 3.3 Value of a Labor Contract as a Function of Wage Rate

Recall Key Questions #1 and #2 from Chapter 1:

- 1) How could a value be placed onto a labor contract as a function of wage rate?
- 2) What implications concern the value of the labor contract as wage rate increases past optimum rate?

In the previous section, the model and the formula for calculating the value of labor was established. In 3.3.1, the formula will be non-dimensionalized in order to provide a generalized solution to the key question. The value of a labor contract will be plotted along the wage rate scale to study the impact of different wage levels. In 3.3.2, sensitivity test results for different values of  $S_{mkt}$  and  $\rho$  will be presented. Finally, in 3.3.3, the implication of the shape of the Labor Contract Value Curve (LCVC) will be discussed.

#### 3.3.1 Normalized Value of Labor Contract Plot Along the *Wage Fraction* Scale

In order to generalize the value of labor contract solution, the formula from 3.2 is first normalized. This is done by dividing the formula by  $\mu$ , the expected value for *adjusted revenue* per time period. The *adjusted revenue* is a rate measure expressing the sum of labor wage premium per period and owner investment return premium per period. The resulting formula is:

$$\frac{(L - L_{rf})}{\left(\frac{\mu}{r_{rf}}\right)} = \frac{w^*}{\mu} \cdot [N_0 + \rho \cdot N_1 \cdot S_{mkt}]$$

or

$$\frac{(L - L_{rf})}{\left(\frac{\mu}{r_{rf}}\right)} = \frac{w^*}{\mu} \cdot N_0 + \frac{w^*}{\mu} \cdot \rho \cdot N_1 \cdot S_{mkt}$$

By performing this division, the left hand term is dimensionless, and the result is normalized. This operation also makes the normalized value of labor contract a function

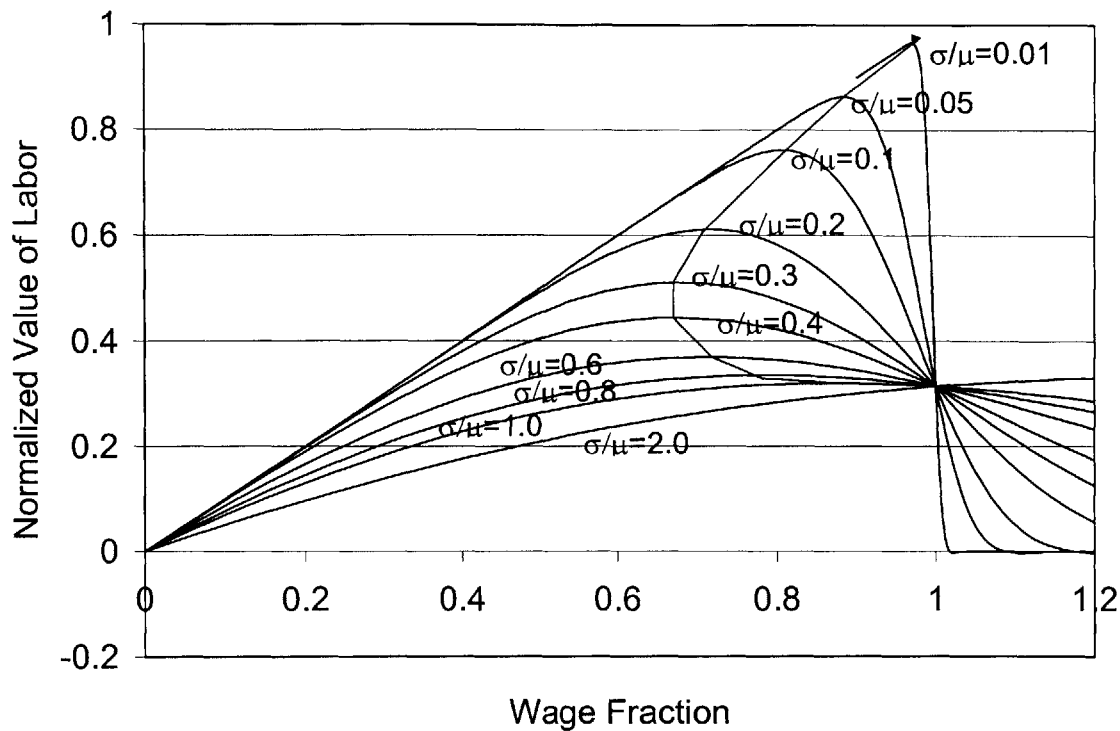
of the term  $w^*/\mu$ . The variable  $w^*$  is the wage premium per time period (wage premium rate), while  $\mu$  is the expected sum of wage premium per time period and owner investment return premium per time period (expected revenue premium rate). The expression  $w^*/\mu$  is essentially the fraction of revenue premium that goes to labor during the time period. It shall be given the name “*Wage Fraction*.” On all plots in this section, *Wage Fraction* is plotted on the x-axis, and the normalized value of labor contract is plotted on the y-axis. Furthermore, *Wage Fraction* is equal to  $(1 - z^* \frac{\sigma}{\mu})$ , where  $(\frac{\sigma}{\mu})$  is the volatility of the adjusted revenue, and  $z$  covers the range of  $-\infty$  to  $+\infty$ .

The first key question is: How could a value be placed onto a labor contract as a function of wage rate? Recall the formula earlier in this section for the normalized value of labor contract:

$$\frac{(L - L_{rf})}{\left(\frac{\mu}{r_{rf}}\right)} = \frac{w^*}{\mu} \cdot [N_0 + \rho \cdot N_1 \cdot S_{mkt}]$$

The independent variable in this formula is the *Wage Fraction*  $w^*/\mu$ , which is a measure of normalized wage rate. The dependent variable in this formula is the normalized value of labor contract. Therefore, this formula provides a methodology to place a value onto a labor contract as a function of wage rate. This formula is the answer to Key Question #1. The focus of the rest of this section will be on the results given by this formula.

By plotting the independent variable on the x-axis and the dependent variable on the y-axis, it is possible to study the shape of this relationship. For each given revenue volatility, one labor contract value curve will result. These curves represent the normalized labor contract value at a given expected revenue volatility, and the curves shall be called the Labor Contract Value Curves (LCVC).



**Figure 3-2: Normalized Labor Contract Value Curves (LCVCs) vs. Wage Fraction**

In Figure 3-2, a sample of LCVCs along the *Wage Fraction* scale is presented. Each individual curve depicted here represents a constant-volatility LCVC curve. Different values of  $(\frac{\sigma}{\mu})$  are used to depict different levels of volatility in *Adjusted Revenue*.

In constructing these curves, the value used for  $\rho$  is 0.35, and the value used for  $S_{mkt}$  is 0.53. The variable  $\rho$  represents the correlation between *Adjusted Revenue* and the market returns, while the variable  $S_{mkt}$  represents the Sharpe Ratio value of the market returns. The assumption  $\rho = 0.35$  is a reasonable value to use as a starting point for this study; this value equals to, for example, the average  $\rho$  value of the US Major airlines. As for  $S_{mkt} = 0.53$ , it is the actual  $S_{mkt}$  value for the S&P 500 returns for the 18 years from 1985 to 2002. Therefore, Figure 3-2 is a reasonable representation of the shape of the LCVCs for a typical company.

In the next section, Section 3.3.2, sensitivity analysis will be performed to study the impact of different values for  $\rho$  and  $S_{mkt}$  values. Next, in Section 3.3.3 the implications of the shape of the LCVC curves will be discussed.

### 3.3.2 Sensitivity Test Results

Before performing further analysis, it is important to perform sensitivity tests for different values of  $\rho$  and  $S_{mkt}$ . By testing different values of  $\rho$  and  $S_{mkt}$ , their effects on the shape of the Labor Contract Value Curves (LCVC) can be observed.

In the value of labor contract formula, the values of  $\rho$  and  $S_{mkt}$  are multiplied together. Therefore, sensitivity testing is done based on the product  $\rho * S_{mkt}$ . For this sensitivity analysis, additional  $\rho$  and  $S_{mkt}$  values are selected to represent the lowest and highest reasonable historical  $\rho * S_{mkt}$  values. For the lower bound value of  $\rho * S_{mkt}$ , a value of  $\rho = 0$  is selected. It is possible for companies to exhibit *Adjusted Revenue* that does not correlate to the overall market at all. An example of such a company is Southwest Airlines. Between 1985 and 2000, the value of  $\rho$  for Southwest Airlines is approximately 0. This results in the lower bound of  $\rho * S_{mkt} = 0$ . There are companies that have historically been able to achieve a negative correlation with the overall market; the shape of their LCVC's will be discussed later in Section 3.3.3.

The historical value of  $S_{mkt}$  for the entire period of 1985-2000 was 0.53, but with a five-year rolling average, the highest  $S_{mkt}$  value was 3.75. The industry selected for the case study later in this thesis is the US airline industry and the highest historical value of  $\rho$  for US Majors was about 0.5. This value of  $\rho$  is selected as the upper value for the sensitivity analysis.  $0.5 * 3.75 = 1.875$  is used as the highest reasonable historical  $\rho * S_{mkt}$  value.



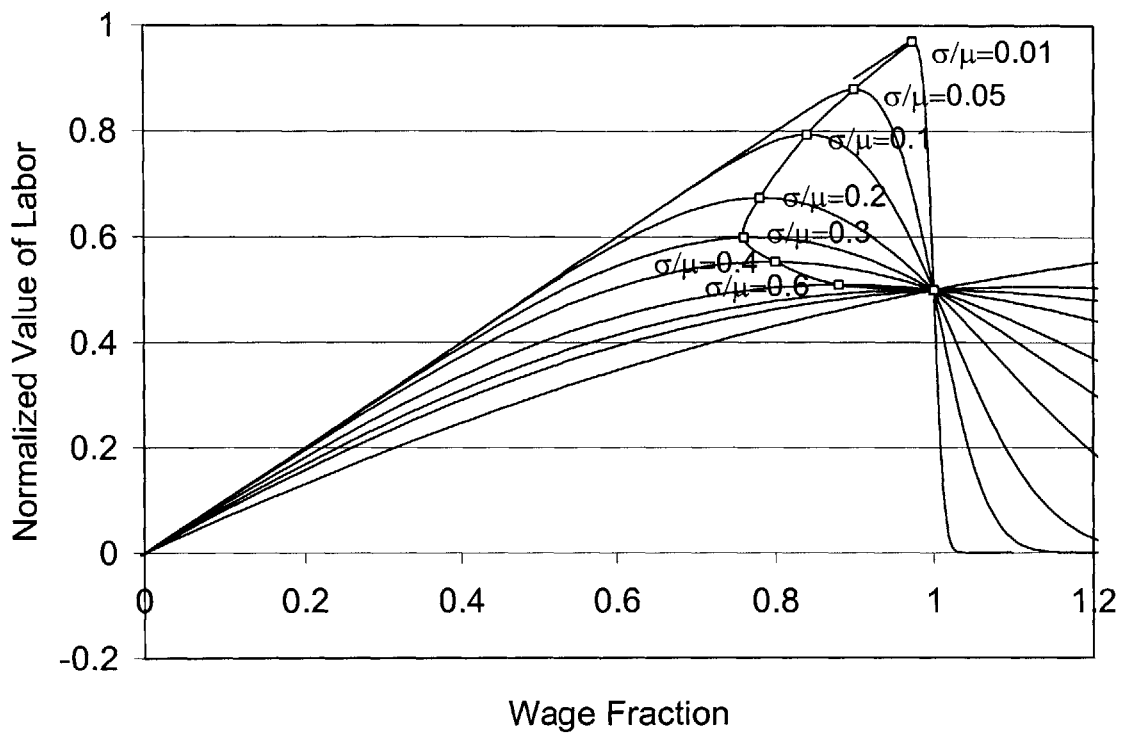


Figure 3-3: Normalized LCVC vs. Wage Fraction,  $\rho^*S_{mkt}=0$

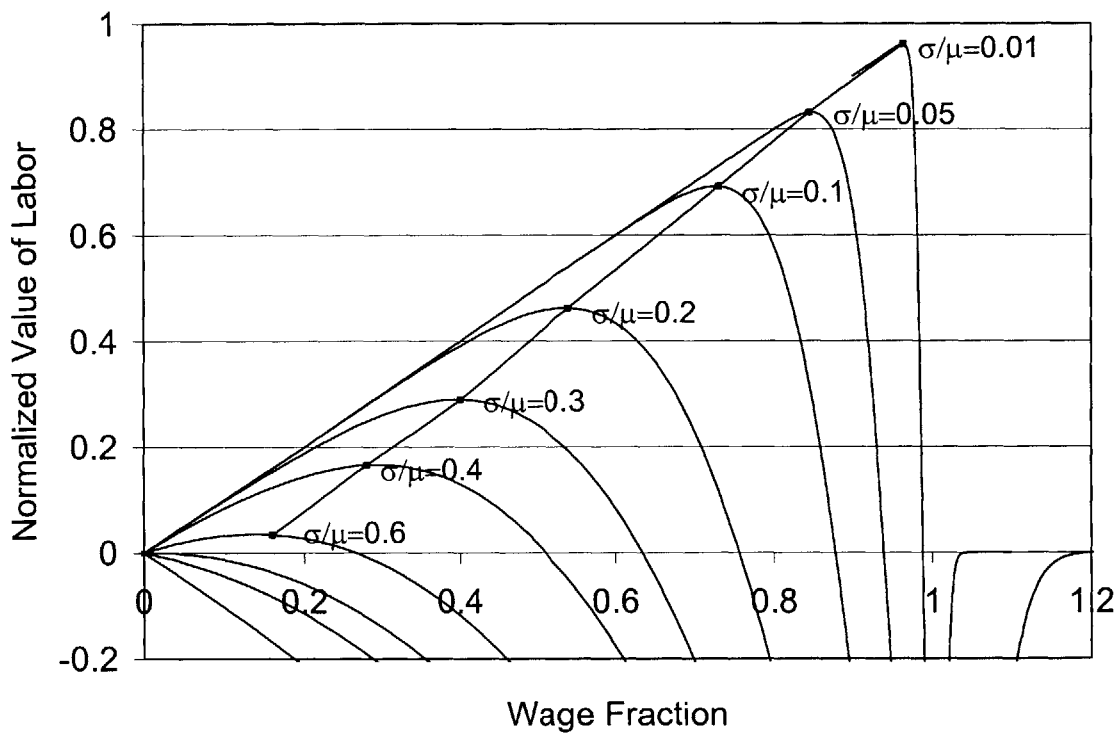


Figure 3-4: Normalized LCVC vs. Wage Fraction,  $\rho^*S_{mkt}=1.875$

In Figure 3-3, the lower values of  $\rho * S_{mkt}$  are presented, and in Figure 3-4, the higher values are presented. Reasonable value range for *Wage Fraction* is from 0 to 1. The maximum value points for the labor contract on the “constant-*Adjusted-Revenue*-volatility LCVC line” are indicated.

The findings of the sensitivity test may be summarized as follows:

- On the  $\rho * S_{mkt} = 0$  graph, all constant revenue volatility LCVC lines converged to 0.5 at *Wage Fraction* = 1. With  $\rho * S_{mkt} = 0$ , the *Adjusted Revenue* of the company has no correlation with the overall market. Recall that the model assumes a normal distribution for the returns. Therefore, the company is equally likely to operate and not to operate, regardless of the company’s own revenue volatility. The result is that the normalized value of the labor contract, when all revenue premiums are given to labor, is 0.5.
- As  $\rho * S_{mkt}$  increases, the convergence point decreases in value. This could be because the Sharpe Ratio of the market increases, making the market more attractive and resulting in a higher probability of the owner deciding not to operate. Recall that the owner would decide to operate if the return in investing in the company is higher than market returns. A higher probability of not operating results in a lower value for labor. A similar mechanism applies with higher values of  $\rho$ . If the company’s revenue premium correlates well with the market, then the stock becomes less attractive to investors who need to diversify to reduce their risk.
- The shape of the LCVC’s suggest to labor groups that, at the same *Wage Fraction* point on the same LCVC line, any increases in  $\rho$  or  $S_{mkt}$  reduce the value of their contract. Companies with low  $\rho$  values, for example, Southwest Airlines, would then be more attractive to investors, increasing their labor value curves.
- These LCVC curves further suggests that as  $\rho * S_{mkt}$  increases, the peak point on the same constant revenue volatility LCVC line initially moves to a lower *Wage Fraction*. If the company is less attractive as an investment, the optimum wage fraction for labor will also decrease.

Therefore, as the value of  $\rho \cdot S_{mkt}$  increases, the company is less attractive to investors, decreasing the probability that the owner will decide to operate the company instead of liquidation. As this probability decreases, the value of a given labor contract decreases. At the same time, the optimal *Wage Fraction* decreases, as more revenue premium needs to be given to owners in order to make the investment returns attractive.

### 3.3.3 Implication of the Shape of the Labor Contract Curve along the *Wage Fraction Scale*

In this section, further analysis of the LCVC curves will be made.

Recall from Section 3.3.1, the formula for the normalized value of labor contract is:

$$\frac{(L - L_{rf})}{\left(\frac{\mu}{r_{rf}}\right)} = \frac{w^*}{\mu} \cdot [N_0 + \rho \cdot N_1 \cdot S_{mkt}]$$

Or, by separating the two terms inside the bracket,

$$\frac{(L - L_{rf})}{\left(\frac{\mu}{r_{rf}}\right)} = \frac{w^*}{\mu} \cdot N_0 + \frac{w^*}{\mu} \cdot \rho \cdot N_1 \cdot S_{mkt}$$

Note in the right-hand side of the second equation that the value is the summation of two terms.

The initial hypothesis for the relationship between wage rate and value of the labor contract is the following: as wage rate increases, initially the value of the labor contract increases as well; however, as wage rate increases to the point where the owner may decide not to operate, the value of the contract starts to decrease. The first term of the formula above,  $\frac{w^*}{\mu} \cdot N_0$ , in fact captures this effect. Here is the result of the first term plotted along the wage fraction scale. In constructing the curves in Figure 3-5, the value used for  $\rho$  is 0.35, the value used for  $S_{mkt}$  is 0.53; this is the same as in Figure 3-2.

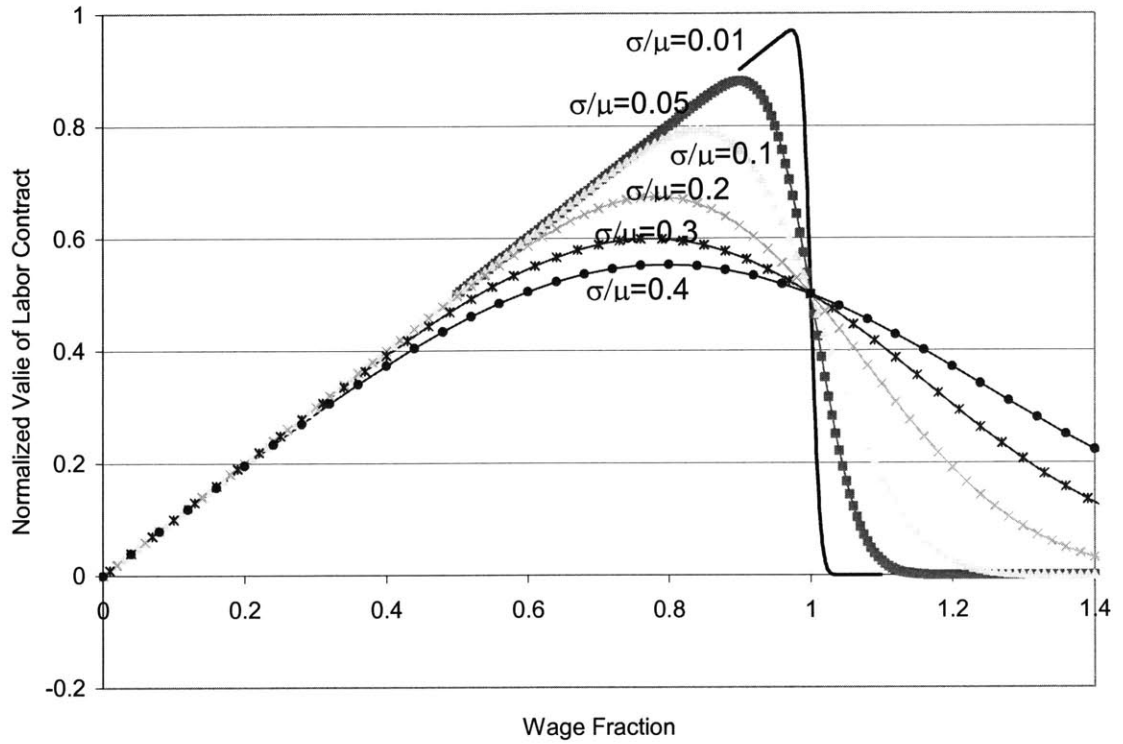


Figure 3-5: The values of 1<sup>st</sup> term:  $\frac{w^*}{\mu} \cdot N_0$

At low revenue volatility (low  $\sigma/\mu$ ; for example,  $\sigma/\mu=0.01$ ), the value of the first term increases linearly until the *Wage Fraction* almost reaches 1. At that point, the probability of not operating increases dramatically, reducing the value of the labor contract to 0. As revenue volatility increases, the point where the value departs the tangent line occurs at a lower *Wage Fraction*. The peak normalized labor contract value also decreases. This reflects the fact that at higher revenue volatility, there is a higher probability that the revenue may not be as high as expected, pushing the owner closer to the shutdown point. The key point here is that maximum labor contract value decreases with increasing revenue volatility.

The second term of the formula for the LCVC is  $\frac{w^*}{\mu} \cdot \rho \cdot N_1(z^*) \cdot S_{mkt}$ . The meaning of this second term is less intuitive compared to the first term. What this term represents is in essence an adjustment to the value of the labor contract. The magnitude of the

adjustment is affected by the correlation of the *Adjusted Revenue* and the overall market returns. In portfolio theory, investors seek to diversify their portfolio in order to achieve higher value and higher returns. If the returns of a company correlate well with the overall market, the value of adding such a security to the overall portfolio may be negative. On the other hand, if the returns of a company do not correlate well with the overall market, then adding such a security would be beneficial to the value of the overall portfolio, making it more desirable. The second term in the formula in essence captures this effect. The value of the 2<sup>nd</sup> term is shown in Figure 3-6, with the same conditions as Figure 3-2.

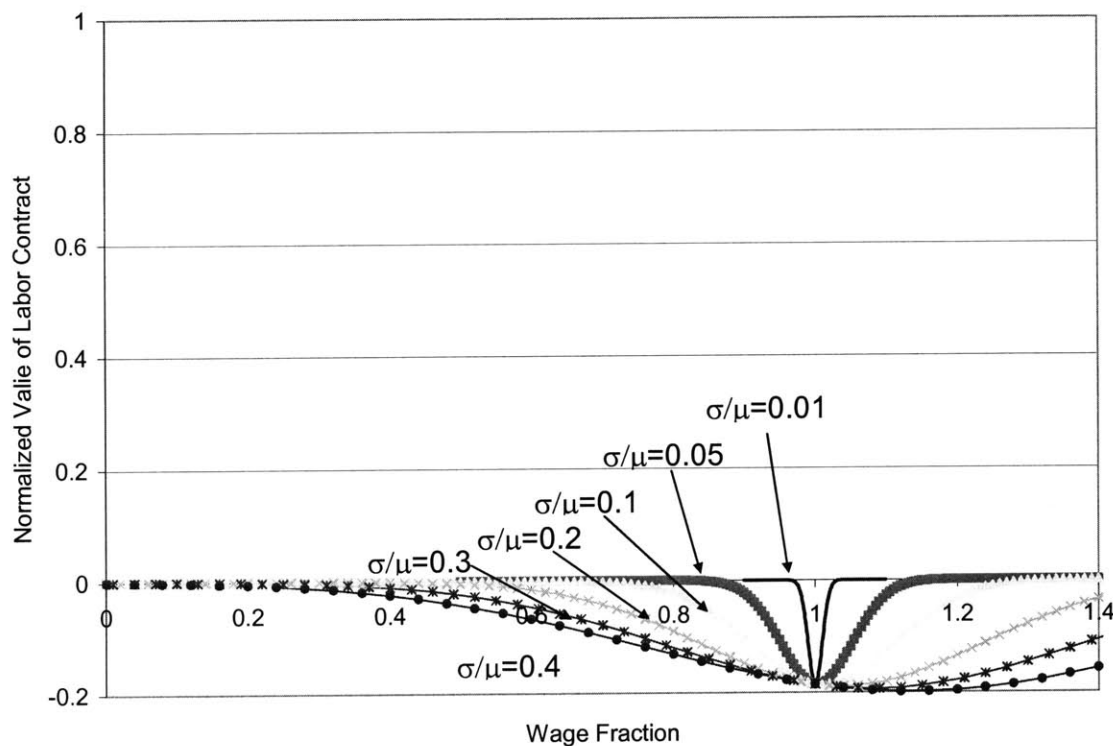
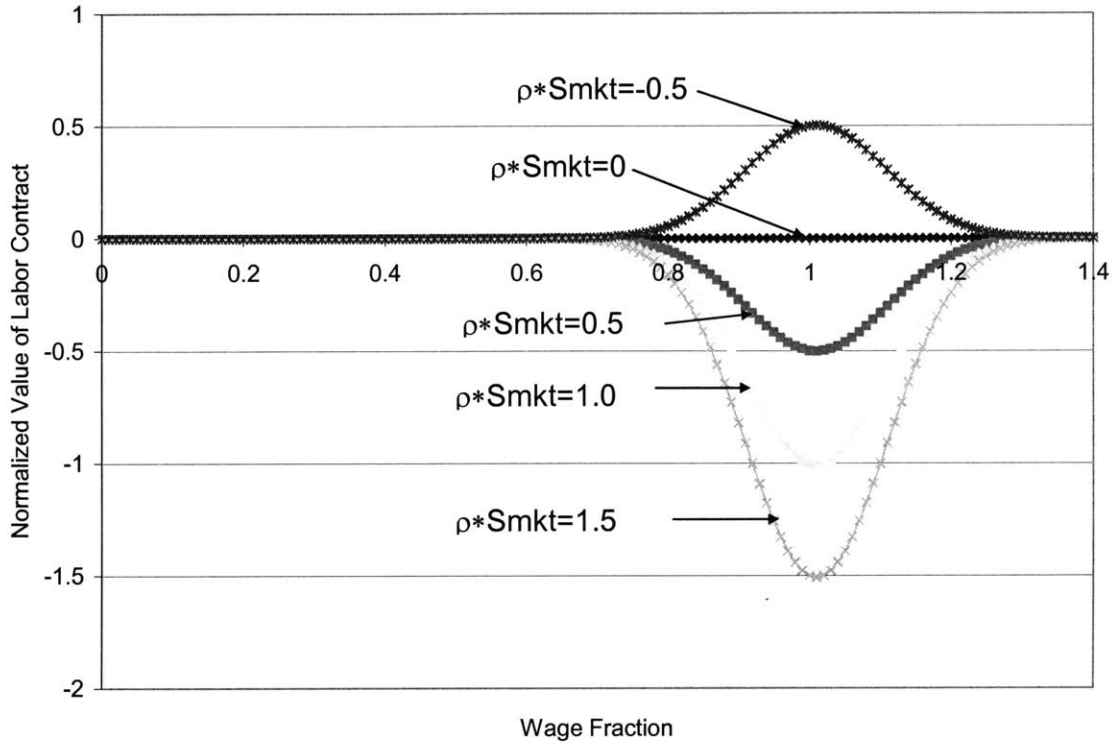


Figure 3-6: The values of 2<sup>nd</sup> term:  $\frac{w^*}{\mu} \cdot \rho \cdot N_1 \cdot S_{mkt}$

The conditions in Figure 3-6 are the same as in Figure 3-2: the value used for  $\rho$  is 0.35, and the value used for  $S_{mkt}$  is 0.53. With a positive value of  $\rho^* S_{mkt}$ , the magnitude of the second term is negative. This is in line with expectations: higher correlation of the returns with the market adds lower value to a portfolio. Also, at higher revenue volatility, the curve is stretched horizontally.

In Figure 3-7, the second term is plotted with different values of  $\rho^*S_{mkt}$ , with  $\sigma/\mu = 0.1$ . A higher value of  $\rho^*S_{mkt}$  should lead to a larger decrease in the value of the labor contract.



**Figure 3-7: The values of 2<sup>nd</sup> term, Revenue Volatility  $\sigma/\mu=0.1$**

The results shown in Figure 3-7 confirm the expectations. As  $\rho^*S_{mkt}$  increases, the value of the second term decreases, resulting in lower overall value of the labor contract. If the *Adjusted Revenue* of a company is negatively correlated with the overall market, then the impact of the 2<sup>nd</sup> term to the value of the labor contract is positive.

Examples of the breakdown of the LCVLC are shown in Figure 3-8. In this graph, the value used for  $\rho$  is 0.35, and the value used for  $S_{mkt}$  is 0.53. This was the same as in Figure 3-2. Two different volatility levels,  $\sigma/\mu=0.01$  and  $\sigma/\mu=0.2$ , are represented. The

graph shows the result of the first term:  $\frac{w^*}{\mu} \cdot N_0$ , the result of the second term:

$\frac{w^*}{\mu} \cdot \rho \cdot N_1 \cdot S_{mkt}$ , and finally the LCVC, which is the summation of the two terms.

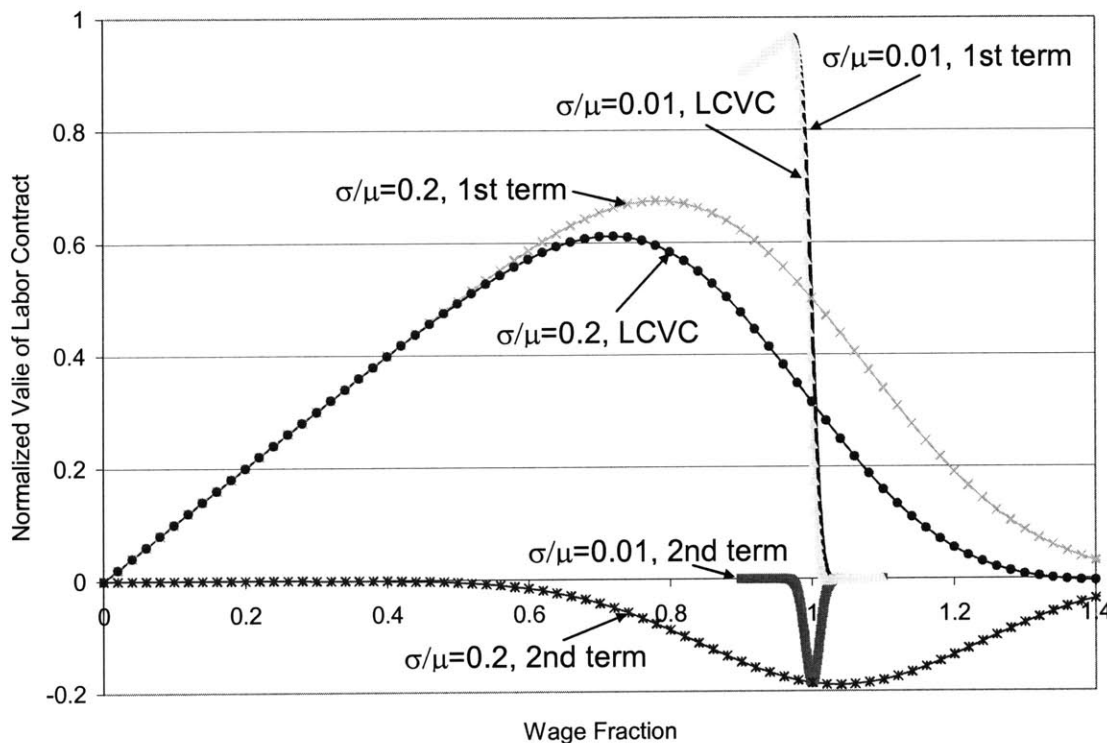


Figure 3-8: Breakdown of LCVC

Since  $\rho$  is positive, the magnitude of the second term is negative. The LCVC is the combination of the two terms and results in a lower value than the first term alone. The value of the labor contract declines due to both of the following factors:

- Factor 1: as wage rate increases, lower probability of the company operating due to lower expected returns to the owner, lowers the value of the contract.
- Factor 2: positive correlation of the company's *Adjusted Revenue* with the overall market further reduces the value of the contract.

While the effect of the first term is intuitive, the effect of the second term is less obvious. The result of combining the two terms is the shape of the LCVC shown in Figure 3-2, repeated here below.

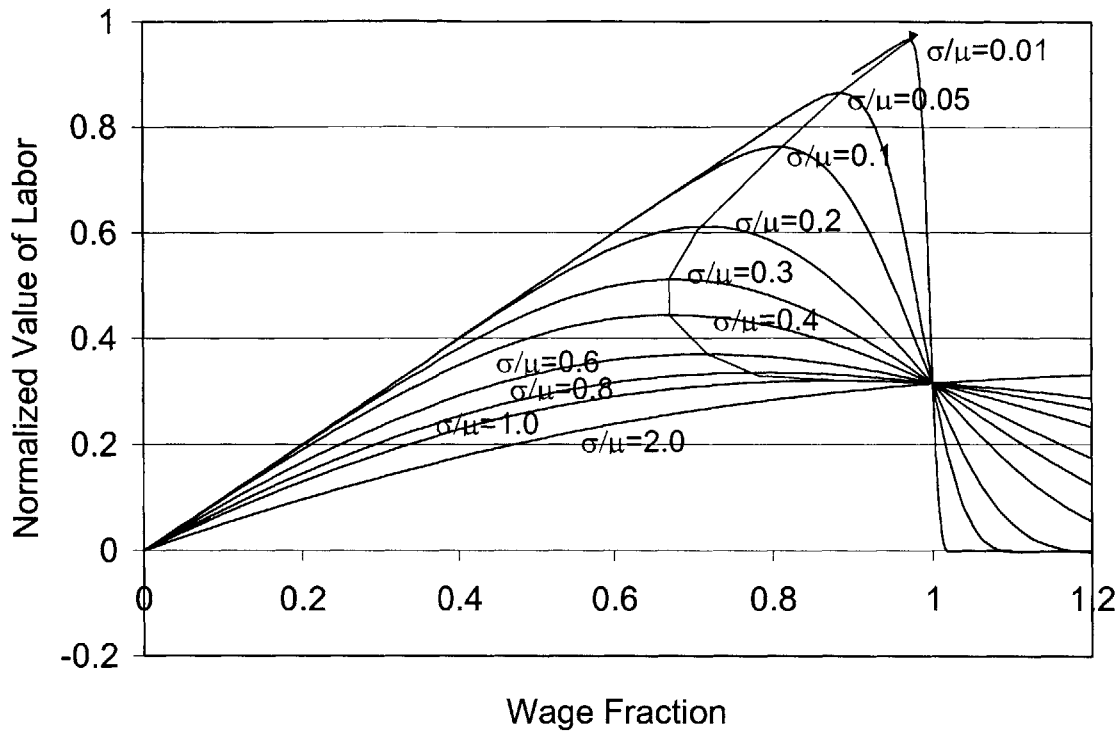


Figure 3-2: Normalized Value of Labor on the *Wage Fraction* Scale

To conclude this section, the implications of the final shape will be discussed.

As *Wage Fraction* increases from 0, labor is receiving a larger fraction of *Adjusted Revenue*, so the value of a labor contract increases. Note that the value of labor contract is normalized by  $\mu$ , the expected value for *Adjusted Revenue*. Since the vertical axis represents the value of the labor contract and the horizontal axis represents *Adjusted Revenue*, the resulting curve should initially lie on a line through the origin with a slope of one. As *Wage Fraction* continues to increase, the summation of the two terms above caused the value of the labor contract to deviate from the line with a slope of one. The value of the labor contract reaches a peak point, followed by a decline. The location of this peak is dependent on both terms. Based on the sensitivity test, under all reasonable conditions, the LCVC's exhibit monotonically decreasing slopes as the *Wage Fraction* is increased. This condition holds true until the normalized value of the labor contract declines toward or past zero. The implication is that there is a single unique maximum value point along a constant revenue volatility LCVC line.



Each company has a different value of revenue volatility ( $\sigma/\mu$ ) based on the historical variation in *Adjusted Revenue*. As the revenue volatility ( $\sigma/\mu$ ) increases, variation in revenue increases, resulting in a higher risk of an owner's decision not to operate and a lower value for the contract. At low revenue volatility ( $\sigma/\mu$ ), the peak around maximum labor contract value appears to be sharp, and the magnitude of the LCVC appears to be high. The significance is that for companies with low revenue volatility, labor groups could achieve a higher value for their contracts, but if the labor contract value is near the peak, a small increase in *Wage Fraction* could result in a sharp reduction in labor contract value. On the other hand, at high revenue volatility, the peak at maximum labor contract value is more rounded, and the peak occurs at a lower value. An increase in *Wage Fraction* past maximum labor contract value does not have as significant of an impact in labor contract value as compared to the case with low revenue volatility.

Because at low revenue volatility the decline in the value of a labor contract is sharp, understanding the position on the *Wage Fraction* scale for the contract would be important for labor groups. The *Optimum Wage Fraction* is defined as the *Wage Fraction* for which labor contract value is maximized along the constant revenue volatility LCVC line. If a company's high revenue volatility ( $\sigma/\mu$ ) results in a large decline, it would be in the labor groups' best interest to find the *Optimum Wage Fraction* and to negotiate a contract *Wage Fraction* smaller than this *Optimum Wage Fraction*.

The key lesson from this section is that each company has different underlying expectations for  $\rho$  and  $\sigma/\mu$ . The shape of each company's LCVC is determined by these terms. It is important to understand the impact of values of  $\rho$  and  $\sigma/\mu$  on the shape of LCVCs. Labor groups want to negotiate contracts that are close to the peak contract value. However, if the expected volatility in *Adjusted Revenue* is low, any changes in revenue could increase the *Wage Fraction*, reducing the value of the labor contract. As *Wage Fraction* increases past *Optimum Wage Fraction*, the value of the labor contract could be significantly reduced. This point answers the Key Question #2 about the implications on the value of the labor contract as wage rate increases past optimum rate.

### 3.4 Comparison of Value of Labor Contracts between Employee Groups

Recall Key Question #3 from Chapter 1:

How could one compare the various labor contract values across different unions within the same company?

The focus of Section 3.3 was the treatment of a labor contract as a tradable security and the use of the Capital Asset Pricing Model (CAPM) to estimate the value of this security, thus placing a hypothetical tradable value on the labor contract. In Section 3.3, it was assumed that there was only one labor group at each company, so only one value for the labor contract was calculated.

In most companies, there could be multiple labor unions. Since a value on the labor contract could be established, the next step would be to make a comparison of contracts between employee groups. Since the labor groups are in the same company, the same underlying revenue fundamentals exist for all groups.

The approach used in this section is to treat contracts for individual labor groups as different securities and to use financial tools related to the CAPM – the Sharpe Ratio in this case – to make a comparison.

#### 3.4.1 *Adjusted Revenue Distribution among Labor Groups*

Professor William Sharpe developed the CAPM used in Section 3.3. He also developed the Sharpe Ratio. He stated that he introduced in 1966 a measure for the performance of mutual funds and proposed the term *reward-to-variability ratio* to describe the measure. Over time, many other researchers have studied generalized versions of this ratio, and this ratio is now commonly referred to as the Sharpe Ratio. (The Journal of Portfolio Management, Fall 1994)

The generalized form of Sharpe Ratio is defined as the following:

$$S = \frac{E(\text{investment\_return} - \text{risk\_free\_return})}{\sqrt{\text{var}(\text{investment\_return} - \text{risk\_free\_return})}}$$

The Sharpe Ratio is the expected return premium divided by the standard deviation of the return premium. As Sharpe described, it is a *reward-to-variability ratio* of mutual fund performance. A higher value of expected return premium increases the value of the Sharpe Ratio of a mutual fund, and a higher value of the standard deviation decreases the value of the Sharpe Ratio of a mutual fund. If one mutual fund were to have a higher Sharpe Ratio value than that for another mutual fund, it would imply that the former mutual fund is more attractive to investors or that the mutual fund has a higher value.

By a similar argument from Section 3.3, the Sharpe Ratio can be used to compare labor contracts of different labor groups within the same company as if labor contracts were tradable securities. One could follow the methodology presented in Section 3.3 to calculate the value of labor contracts of the individual labor groups. However, recall that the *Wage Fraction* for labor is calculated based on the wage rate as well as the expected *Adjusted Revenue*. The allocation of *Adjusted Revenue* to the different labor groups could pose a significant problem. To avoid the revenue allocation problem, the Sharpe Ratio performance measure comparison is chosen.

In order to make comparisons between two labor groups, the equilibrium condition has to be defined. When comparing two securities using the Sharpe Ratio, the equilibrium point is where the Sharpe Ratios of the two securities are equal. If the Sharpe Ratio is higher for one security, that security becomes more attractive to investors, increasing its demand. This would lead to an increase in the price of the security, and thus reducing the Sharpe Ratio value.

Labor contracts are not tradable securities in the physical sense. However, since labor receives fixed payments similar to a bond, it is possible to create a duplicating security in the form of a bond. This is the same as the approach used in Section 3.3 to calculate a value for the labor contract. The values calculated for the contract would be analogous to the value of the hypothetical bond. A worker holding a contract could sell his future

income stream as if they are periodic bond payments, and realize the face value of the contract. The market would price the duplicating bond by using the calculations introduced in Section 3.3. If one labor group holds a contract with a higher Sharpe Ratio value than that for another labor group, the value of that contract would increase, arriving at the equilibrium condition where the Sharpe Ratios of all contracts are the same.

One could argue that comparing pay premiums across labor groups may be unfair. It is true that some jobs may require a higher level of education than others, and some jobs may deserve a higher level of compensation. However, recall that all wages are compared to the respective risk-free wage. One labor group will have a different risk-free wage from another labor group, and the risk-free wage is selected based on the equivalent skill levels required for each labor group.

In summary, under the equilibrium condition, investors are indifferent between the duplicating bonds of two labor groups if the Sharpe Ratios of the two labor group contracts are equal. Setting the Sharpe Ratios equal between two contracts allows the contracts to be comparable.

Finally, another point to note is that in Section 3.3, the CAPM assumes that the asset markets are frictionless. In order to compare the Sharpe Ratios between two labor contracts, the assumption has to be relaxed. If the assumption is not relaxed, the result for the Sharpe Ratio comparison is  $0/0$  – undefined because the denominator of the ratio would be zero. In this section, it is assumed that there is a frictional loss fraction  $\delta$  for an employee to switch to a risk-free job.  $\delta$  is defined as the fraction of the risk-free wage rate the employee would lose if he/she has to switch to a risk-free job. The frictional loss fraction  $\delta$  is assumed to be small in magnitude relative to the wage rate. Since  $\delta$  is imposed on all employee groups and its value is small, the variable does not appear to affect the analysis.

Because the Sharpe Ratio involves the expected value and the variance of investment return premium, this quantity is first defined:

Investment Premium = Investment Return – Risk Free return =

$w_2\Delta t - w_1\Delta t$  , with probability  $p$

$-\delta_b w_1\Delta t$  , with probability  $1-p$

where:

$p$  = a priori probability of survival (company operating)

$w_1$  = risk free wage rate

$w_2$  = labor wage rate

$\delta$  = frictional loss fraction for labor if decide to seek the risk free alternative

The reason for using wage rate is that when most people think of salaries, they think of dollars per year. This salary value is in essence a wage rate, and multiplying it by the time length of the time period yields the total salary for the entire time period. Since the time period for all labor groups will be the same, inflation factor is ignored, and the time term will be cancelled.

To calculate labor's Sharpe ratio:

$$E(w_2\Delta t - w_1\Delta t) = p(w_2\Delta t - w_1\Delta t) + (1-p)(-\delta w_1\Delta t)$$

$$E[(w_2\Delta t - w_1\Delta t)^2] = p(w_2\Delta t - w_1\Delta t)^2 + (1-p)(-\delta w_1\Delta t)^2$$

Assume  $\delta w_1$  is small, so  $(\delta w_1\Delta t)^2 \approx 0$

$$\therefore E[(w_2\Delta t - w_1\Delta t)^2] = p(w_2\Delta t - w_1\Delta t)^2$$

$$\begin{aligned} E[(w_2\Delta t - w_1\Delta t)]^2 &= [p(w_2\Delta t - w_1\Delta t) + (1-p)(-\delta w_1\Delta t)] * [p(w_2\Delta t - w_1\Delta t) + (1-p)(-\delta w_1\Delta t)] \\ &= p^2(w_2\Delta t - w_1\Delta t)^2 - 2p(1-p)(w_2\Delta t - w_1\Delta t)(\delta w_1\Delta t) + (1-p)^2(\delta w_1\Delta t)^2 \end{aligned}$$

Assume  $\delta w_1$  is small, so  $(\delta w_1\Delta t)^2 = 0$

$$\therefore E[(w_2\Delta t - w_1\Delta t)]^2 = p^2(w_2\Delta t - w_1\Delta t)^2 - 2p(1-p)(w_2\Delta t - w_1\Delta t)(\delta w_1\Delta t)$$

Substitute the equations above into the Sharpe Ratio formula:

$$S = \frac{E(\text{investment\_return} - \text{risk\_free\_return})}{\sqrt{\text{var}(\text{investment\_return} - \text{risk\_free\_return})}}$$

$$\begin{aligned} S^2 &= \frac{[E(w_2\Delta t - w_1\Delta t)]^2}{\text{var}(w_2\Delta t - w_1\Delta t)} = \frac{[E(w_2\Delta t - w_1\Delta t)]^2}{E[(w_2\Delta t - w_1\Delta t)^2] - [E(w_2\Delta t - w_1\Delta t)]^2} \\ &= \frac{p^2(w_2\Delta t - w_1\Delta t)^2 - 2p(1-p)(w_2\Delta t - w_1\Delta t)(\delta w_1\Delta t)}{p(w_2\Delta t - w_1\Delta t)^2 - p^2(w_2\Delta t - w_1\Delta t)^2 + 2p(1-p)(w_2\Delta t - w_1\Delta t)(\delta w_1\Delta t)} \end{aligned}$$

$(w_2\Delta t - w_1\Delta t)$  and  $p$  cancels out from top and bottom,

$$= \frac{p(w_2\Delta t - w_1\Delta t) - 2(1-p)(\delta w_1\Delta t)}{(1-p)(w_2\Delta t - w_1\Delta t) + 2(1-p)(\delta w_1\Delta t)}$$

$$= \frac{p}{1-p} \frac{[1 - 2\frac{(1-p)}{p} \frac{\delta w_1\Delta t}{w_2\Delta t - w_1\Delta t}]}{[1 + \frac{2\delta w_1\Delta t}{w_2\Delta t - w_1\Delta t}]}$$

$$\therefore S = \sqrt{\frac{p}{1-p}} \sqrt{\frac{[1 - 2\frac{(1-p)}{p} \frac{\delta w_1\Delta t}{w_2\Delta t - w_1\Delta t}]}{[1 + \frac{2\delta w_1\Delta t}{w_2\Delta t - w_1\Delta t}]}}$$

multiply the second square root by  $\frac{1 - \frac{2\delta w_1\Delta t}{w_2\Delta t - w_1\Delta t}}{1 - \frac{2\delta w_1\Delta t}{w_2\Delta t - w_1\Delta t}}$  and ignore higher order terms ( $\delta w_1$  is

very small)

$$\begin{aligned} S &= \sqrt{\frac{p}{1-p}} \sqrt{1 - \frac{2\delta w_1\Delta t}{w_2\Delta t - w_1\Delta t} - 2\frac{(1-p)}{p} \frac{\delta w_1\Delta t}{w_2\Delta t - w_1\Delta t}} \\ &= \sqrt{\frac{p}{1-p}} \sqrt{1 - \frac{2\delta w_1\Delta t}{p(w_2\Delta t - w_1\Delta t)}} \end{aligned}$$

Linearize and evaluate around  $\delta w_1 = 0$ , and divide top and bottom by  $\Delta t$ ,

$$S = \sqrt{\frac{p}{1-p}} \left[ 1 + \frac{1}{2} \left( 1 - \frac{2\delta w_1\Delta t}{p(w_2\Delta t - w_1\Delta t)} \right)^{\frac{1}{2}} \right]_{\delta w_1=0} \left( -\frac{2\delta w_1\Delta t}{p(w_2\Delta t - w_1\Delta t)} \right)$$

$$\therefore S = \sqrt{\frac{p}{1-p}} \left(1 - \frac{\delta w_1}{p(w_2 - w_1)}\right)$$

Divide top and bottom by  $w_1$ ,

$$\therefore S = \sqrt{\frac{p}{1-p}} \left(1 - \frac{\delta}{p(\frac{w_2}{w_1} - 1)}\right)$$

This is the Sharpe Ratio for each labor group.

Recall the argument made earlier that two contracts are in equilibrium when the values of the Sharpe Ratios are equal. Suppose there are two labor groups: “Group a” and “Group b”. The equilibrium condition is then:

$$S_a = \sqrt{\frac{p}{1-p}} \left(1 - \frac{\delta_a}{p(\frac{w_{2a}}{w_{1a}} - 1)}\right) = \sqrt{\frac{p}{1-p}} \left(1 - \frac{\delta_b}{p(\frac{w_{2b}}{w_{1b}} - 1)}\right) = S_b$$

$$\therefore \frac{\frac{w_{2b}}{w_{1b}} - 1}{\frac{w_{2a}}{w_{1a}} - 1} = \frac{\delta_b}{\delta_a}$$

Or,

$$\ln\left(\frac{w_{2b}}{w_{1b}} - 1\right) - \ln\left(\frac{w_{2a}}{w_{1a}} - 1\right) = \ln\left(\frac{\delta_b}{\delta_a}\right)$$

Here are the implications of the above formula:

- 1) If the original CAPM assumption of no friction is made, the formula is mathematically undefined.
- 2) Under equilibrium conditions, between two labor groups, the ratio of pay premium is equal to the ratio of the frictional loss fraction. The pay premium is tied to the difficulty in finding the alternative risk-free job.
- 3) Under equilibrium conditions, if the value of frictional loss fraction is assumed to be equal between two labor groups, ( $\delta_a = \delta_b$ ), then the wage premium percentage of the two groups are equal ( $w_{2b}/w_{1b} = w_{2a}/w_{1a}$ )

- 4) When the value of frictional loss fraction is not equal between the two labor groups but the appropriate risk free wage can be chosen, it is possible to calculate the relative implied frictional loss fraction values.

By applying the equilibrium condition, it is possible to answer the Key Question #3 of how one could compare the various labor contract values across different unions within the same company.



### 3.5 Summary

The following three key questions have been addressed in this chapter:

- 1) How could a value be placed onto a labor contract as a function of wage rate?
- 2) What implications concern the value of the labor contract as wage rate increases past optimum rate?
- 3) How could one compare the various labor contract values across different unions within the same company?

To answer Key Question #1, the Capital Asset Pricing Model (CAPM) was extended to calculate a value for a labor contract. The CAPM was designed to calculate the expected returns of a portfolio. Because labor contracts are similar to securities in the sense that labor receives payments over time, a duplicating security could be constructed. The CAPM equation can be used to calculate the inferred value for the duplicating security. The value of this duplicating security could be used as the value of the labor contract. The normalized value of the labor contract, as a function of wage rate, is:

$$\frac{(L - L_{rf})}{\left(\frac{\mu}{r_{rf}}\right)} = \frac{w^*}{\mu} \cdot N_0 + \frac{w^*}{\mu} \cdot \rho \cdot N_1 \cdot S_{mkt}$$

The result of this formula, when plotted against wage rate, is called the Labor Contract Value Curve (LCVC). The shape of the LCVC is affected by the two terms that make up the labor value formula. The LCVC curves are monotonically decreasing, resulting in a unique maximum point for the labor contract value.

As for Key Question #2, it was found that with low revenue volatility, if wage rate increases past the optimum point, the value for labor contracts could decline significantly. Since all stakeholders seek to achieve maximum utility at the end of the time period, it is understandable that labor groups may want to negotiate contracts that achieve the maximum value for the contracts. However due to the dynamic nature of the business environment, it is possible that the wage rate could increase past the optimum point,

resulting in poor labor contract value. The dynamic aspect of this phenomenon will be discussed in more detail in the next chapter.

Finally, to answer Key Question #3, an equilibrium condition is established. By using the Sharpe Ratio measurement and setting the equilibrium condition, it is possible to make a comparison of labor contract value across labor groups. The resulting formula is:

$$\therefore \frac{\frac{w_{2b} - 1}{w_{1b}}}{\frac{w_{2a} - 1}{w_{1a}}} = \frac{\delta_b}{\delta_a}$$

This formula suggests that between two labor groups, the ratio of pay premium is equal to the ratio of the frictional loss fraction values. The pay premium is tied to the difficulty in finding the alternative risk-free job.

## CHAPTER 4

# SYSTEM DYNAMICS MODELING OF THE IMPACT OF DYNAMIC BEHAVIOR ON THE VALUE OF A LABOR CONTRACT

The fourth key question raised in Chapter 1 is the following:

- 4) When the labor contract value is at its peak, how could the time delay between profit and changes in pay affect the value of the labor contract?

The system dynamics model presented was constructed to study the dynamics of pay and profitability on the value of the labor contract.

In Chapter 3, it was discussed that the shape of the Labor Contract Value Curve (LCVC) along the *Wage Fraction* axis is concave. The position of each company's LCVC is dependent on the expectation of their *Adjusted Revenue* going forward, while the expectation is based on past revenue history, assuming the variation in revenue for a given company will stay constant going forward. For labor groups, in order to achieve the highest value for their labor contracts, it is ideal to negotiate a contract for which the *Wage Fraction* value results in peak labor contract value.

Since the *Wage Fraction* is determined by both wage rate as well as operating profit of a company, as profitability changes *Wage Fraction* changes as well. Recall that *Wage Fraction* is defined as the following:

$$\text{Wage Fraction} = w^*/\mu$$

Where:

$w^*$  = wage premium rate

$\mu$  =  $E[\text{Adjusted Revenue}]$

*Adjusted Revenue* = labor wage premium + owner investment return premium (profit)

Once a contract is signed into effect, if the expected operating profit of a company decreases, it reduces the denominator and increases the value of *Wage Fraction*. The impact is that the operating point of the company would move to the right on the LCVC. If the negotiated contract was at a *Wage Fraction* that resulted in peak contract value, then any subsequent decrease in operating profit would decrease the value of the labor contract. Recall from Chapter 3 that the drop off in labor contract value may be large once the *Wage Fraction* is past the optimal point; if the *Wage Fraction* is close to the point which provides peak labor contract value, a further increase in *Wage Fraction* could result in a large decline in labor contract value. In summary, due to the shape of the LCVC, a peak-value contract could significantly reduce its value, if the expected profit of the company decreases.

In this chapter, a system dynamics model will be constructed to study the interaction between labor pay, profitability, and labor contract value. In constructing the system dynamics model, two assumptions were made. The first assumption is that changes in labor pay could be related to changes in operating profit. The second assumption is that changes in productivity could be related to changes in pay. The focus of the key question is on the impact of delay on the overall dynamics of pay, profitability, and value of the contract. This delay is the delay between changes in labor pay and changes in operating profit.

## **4.1 System Dynamics Model of Profitability and Employee Compensation**

### **4.1.1 Model Requirements and Tool Selection**

In order to study the relationship between labor cost and profitability, the first step is to construct a model of a company. This model needs to be constructed to allow study of how various parameters interact with each other. The parameters are selected to simplify the company model. Only parameters related to labor cost and company profitability will be included. The parameters are linked together by a set of equations, representing definitions and assumptions. The company model would then be a set of simultaneous equations representing the various attributes of a company. Since this class of models is frequently used in engineering and management fields, a whole area of research called System Dynamics has been established

While it is possible to use other modeling techniques to study this labor and profitability relationship, system dynamics simulation is chosen for this research. With a set of simultaneous equations representing a company, it may be difficult to solve these equations simultaneously. System Dynamics modeling was developed specifically for this kind of modeling requirements. Instead of solving the equations, computer simulation is employed to study how the parameters affect each other, and how the values of parameters change over time. Since the focus of this study is to examine the dynamics aspect of the relationship between labor pay and company profitability, System Dynamics model simulation is a tool perfectly suited for this purpose.

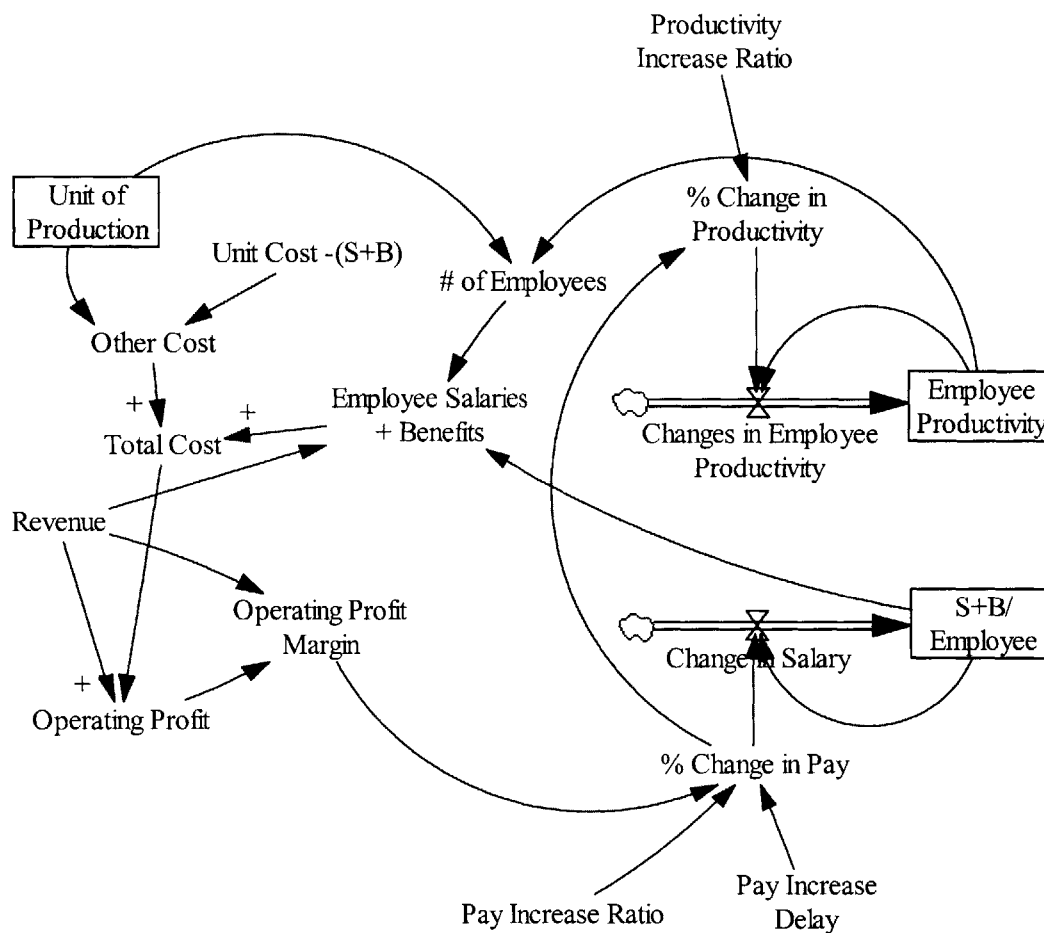
In using a system dynamics model, it is important to note its inherent limitations (Sterman, 2000). System dynamics models focus on capturing the casual relationships between variables. The results are intended to provide an insight into the dynamic behavior of the system being modeled. It is important to note that it is not intended to duplicate the real world exactly. What is important is whether the behavior predicted by

the model is the correct behavior. The useful product of a system dynamics simulation is to use these results to understand the implications of policy decisions.

#### **4.1.2 The Salaries and Benefits System Dynamics Model**

The purpose of the Salaries and Benefits System Dynamics Model is to provide a simulation tool to study the dynamics between operating profit, labor compensation, and the value of the labor contract. This section will describe the model in detail.

Operating profit margin is chosen to be the gauge of company operating performance. While other parameters such as net income or liquidity may be a better gauge for the probability that owners may decide not to operate, many external factors affecting these parameters cannot be easily modeled in this system dynamics model. These external factors also are not directly related to labor pay, and in order to keep the model simple and comprehensible, these outside factors are excluded. Since operating profit margin is directly affected by labor cost and productivity, it is chosen to be the gauge of company operating performance.



**Figure 4-1: The Salaries and Benefits Systems Dynamics Model**

The causal loop diagram for the Salaries and Benefits Systems Dynamics Model is illustrated in Figure 4-1. Causal loop diagrams are often used to explain system dynamics models. The arrows in the diagram indicate the direction of the causal relationship between parameters. Various nodes in the causal loop diagram represent parameters of the model, while various links represent the information flow between various parameters. Each parameter has an equation or a function associated with it. The equations are either definitions or assumptions, and inputs are indicated by the arrow links. This model is focusing on labor pay, labor productivity, labor cost, and the impact on profitability. Only parameters relevant to the above are modeled, while all other variables are simplified as much as possible to avoid confusion.

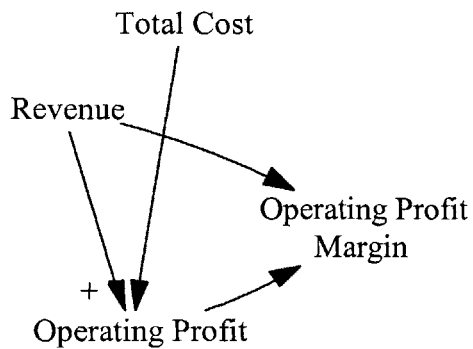
It is important to discuss the simplifications made in this system dynamics model. Here are the simplifications:

- 1) This model represents only one company. All outside influences, such as contracts signed at other companies, are ignored. The rationale for ignoring outside factors is that the focus of this experiment is to look at the impacts of pay on a single company, and having external factors would not help in understanding the problem.
- 2) Total revenue of the company is treated as an external input, and is not influenced by variables in the model such as labor pay or labor productivity. One could argue that management and employee relationships may have a small impact on revenue. This effect is hard to capture, as there is no way to measure employee morale, and it is difficult to prove the link between employee morale and revenue. Therefore for this model it is assumed that revenue for the company is an external variable.
- 3) This model makes the assumption that changes in labor cost do not affect other cost categories, such as material cost, for example. All costs other than labor cost are considered “other” cost, and are treated as sunk cost. This term is represented in the model by a fixed auxiliary variable (“*unit cost*  $-(S+B)$ ” in the model; short for unit cost minus salaries and benefits cost).
- 4) Finally, it is assumed that changes in productivity only affect the number of units produced and number of employees, and it does not change revenue. The decision of how many units to produce during each time period is predetermined, so *Unit of Production* is treated as an external variable. The number of employees is assumed to be flexible and is dependent on productivity. The assumptions of this model are made to filter out white noise, and only variables directly relevant to labor cost and operating profit are modeled so that the dynamics could be easily understood.

The following section explains the various equations and hypotheses (links) of this system dynamics model.



The company's operating performance is measured by *Operating Profit Margin*, as illustrated in Figure 4-2.



**Figure 4-2: Calculation of Operating Profit Margin**

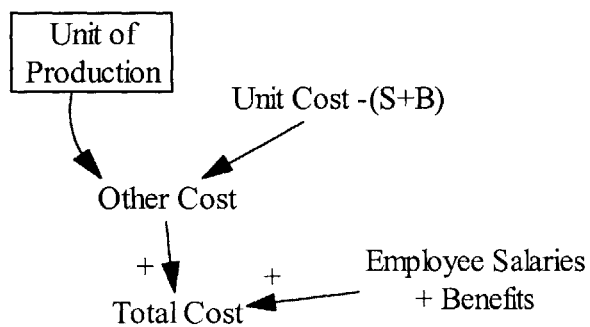
The equations defining *Operating Profit Margin* and *Operating Profit* are definitions.

$$\text{Operating Profit Margin} = \text{Operating Profit} / \text{Revenue}$$

$$\text{Operating Profit} = \text{Revenue} - \text{Total Cost}$$

Airlines are price takers, and revenue is treated as an external variable.

The calculation of *Total Cost* is illustrated in Figure 4-3.

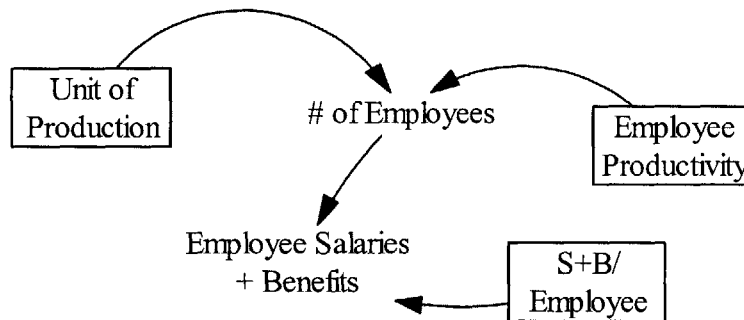


**Figure 4-3: Calculation of Total Operating Cost**

The equation defining *Total Cost* is a definition.

$$\text{Total Cost} = \text{Employee Salaries \& Benefits} + \text{Other Cost}$$

As mentioned earlier, this model makes the assumption that changes in labor cost are independent of changes in other cost. This *Other Cost* term is calculated by *Unit of Production \* Unit Cost (-S+B)*. *Unit Cost (-S+B)* denotes the unit cost of the company, with the Salaries & Benefits component subtracted. The model uses a unitized approach for cost, and both *Other Cost* and *Employee Salaries and Benefits* are calculated on a per *Unit* basis. This is done so that scale changes does not change the value of the “operating profit margin” variable.



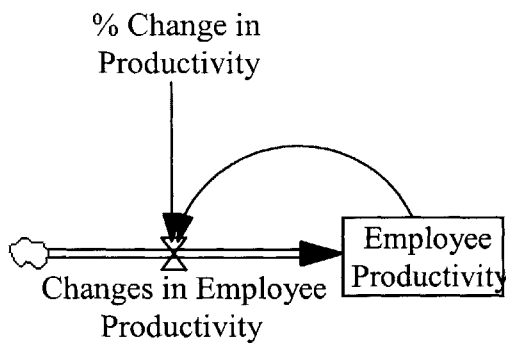
**Figure 4-4: Calculation of Employee Salaries + Benefits**

*Employee Salaries + Benefits* is also calculated on a unitized basis; its formulation is illustrated in Figure 4-4.

$$\text{Employee Salaries} + \text{Benefits} = (\# \text{ of Employees}) * (S+B/\text{Employee})$$

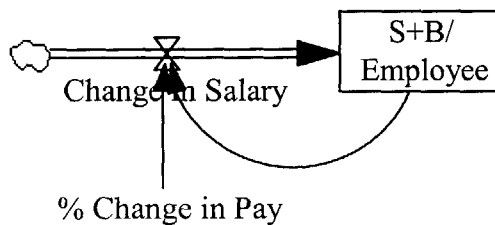
$$\# \text{ of Employees} = \text{Unit of Production} / \text{Employee Productivity}$$

*Employee Productivity* is defined as *Unit of Production* per Employee. Other productivity measures could have been used, but since the purpose of the productivity variable is to calculate *# of Employees* and *Employee Salaries + Benefits*, it does not matter what definition of employee productivity is used here as long as the proper external variable is included in the model.



**Figure 4-5: Calculation of Employee Productivity**

In Figure 4-5, the calculation of *Employee Productivity*, defined as *Unit of Production* per employee, is explained. The “valve and level” tool of system dynamics modeling is used here to track the level of employee productivity. An initial value for *Employee Productivity* is input into the model. For every subsequent simulation time frame, the value of *Employee Productivity* is changed by *Changes in Employee Productivity*, which is in turn calculated by  $\% \text{ Change in Productivity} * \text{Employee Productivity}$ . For each simulation time frame, the value of *Employee Productivity* is changed by the amount of the variable  $\% \text{ Change in Productivity}$ .



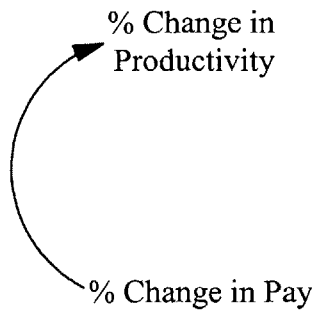
**Figure 4-6: Calculation of S+B/Employee**

The calculation of  $S+B/\text{Employee}$  is illustrated in Figure 4-6.

$S+B/\text{Employee}$  stands for salaries and benefits per employee, and it is calculated in a similar way to *Employee Productivity*. At the beginning of the simulation, an initial

value for  $S+B/Employee$  is assigned. For each simulation period, its value is modified by *% Change in Pay*.

The relationships presented so far are definitions; the next two relations are hypotheses. Earlier it was mentioned that two assumptions were made in constructing the model. One assumption was that changes in pay is affected by profitability, and another assumption was that productivity is affected by changes in pay. The first hypothesis here is made based on the assumption that productivity is affected by changes in pay.



**Figure 4-7: Hypothesis linking % Change in Productivity to % Change in Pay**

The hypothesis link between *% Change in Pay* and *% Change in Productivity* is illustrated in Figure 4-7. The hypothesis this link represents is that *% Change in Productivity* is affected by *% Change in Pay*. The rationale for this hypothesis is that when employees receive a pay increase, management may ask them to be more productive in return. Also, higher pay could lead to better morale, resulting in better employee attendance and higher productivity.

Since the relationship between *Changes in Productivity* and *Changes in Salaries* is a hypothesis, let this coefficient for *Changes in Salaries* be “*Productivity Increase Ratio*”. In the simulation runs, this “*Productivity Increase Ratio*” coefficient will be changed to simulate the effect of productivity improvements that may be agreed upon with new contracts.



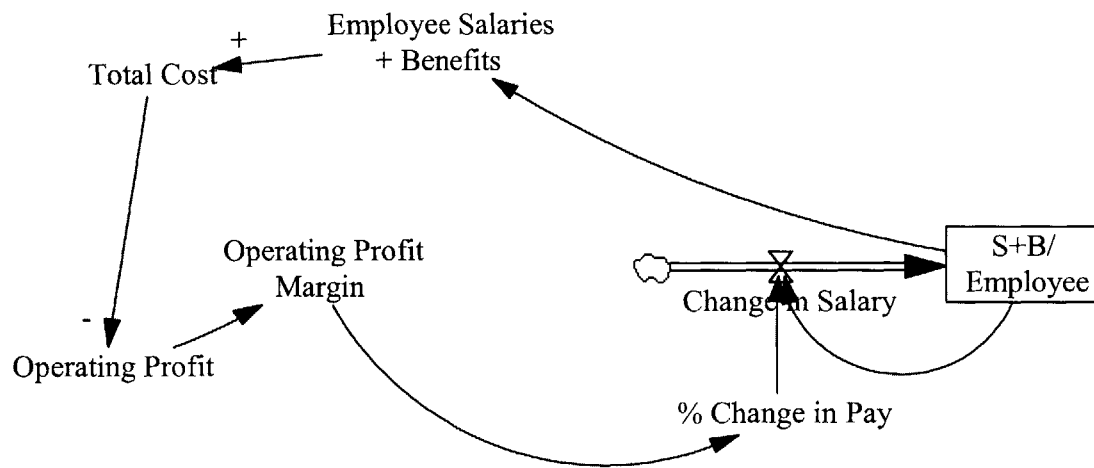
**Figure 4-8: Hypothesis linking % Change in Pay to Operating Profit Margin**

The hypothesis link represented in Figure 4-8 is that *% Change in Pay* is affected by *Operating Profit Margin*. This is related to the assumption that changes in pay is affected by profitability. During negotiations, it is possible that targets or expectations from both sides may be influenced by past or current performance of the company. When the company is producing high operating profit margins, unions may want a larger pay increase, while if the company is performing poorly, management may not be able to give unions any pay increase at all. This link represents the hypothesis that *% Change in Pay* may be linked to *Operating Profit Margin* of the company. Let the coefficient for *% Change in Pay* be “*Pay Increase Ratio*”.

Another variable that is captured by this link is the possible delay between profit and pay. With traditional contracts, each new contract could be negotiated for a long period of time, such as three years or more. New contracts usually detail the exact pay increase schedule for the duration of the contract. On top of the contract duration, it may take an insignificant amount of time for labor and management to reach a contract agreement. This leads to an even longer delay between profit and actual pay increase. Due to the cyclical nature of the business environment, this long delay may lead to profit changes and pay changes being out of phase. The impact of this delay on the value of labor contracts is the focus of this simulation. In this model, another variable, “*Pay Increase Delay*,” is used to control the delay associated with the link between profit and pay.

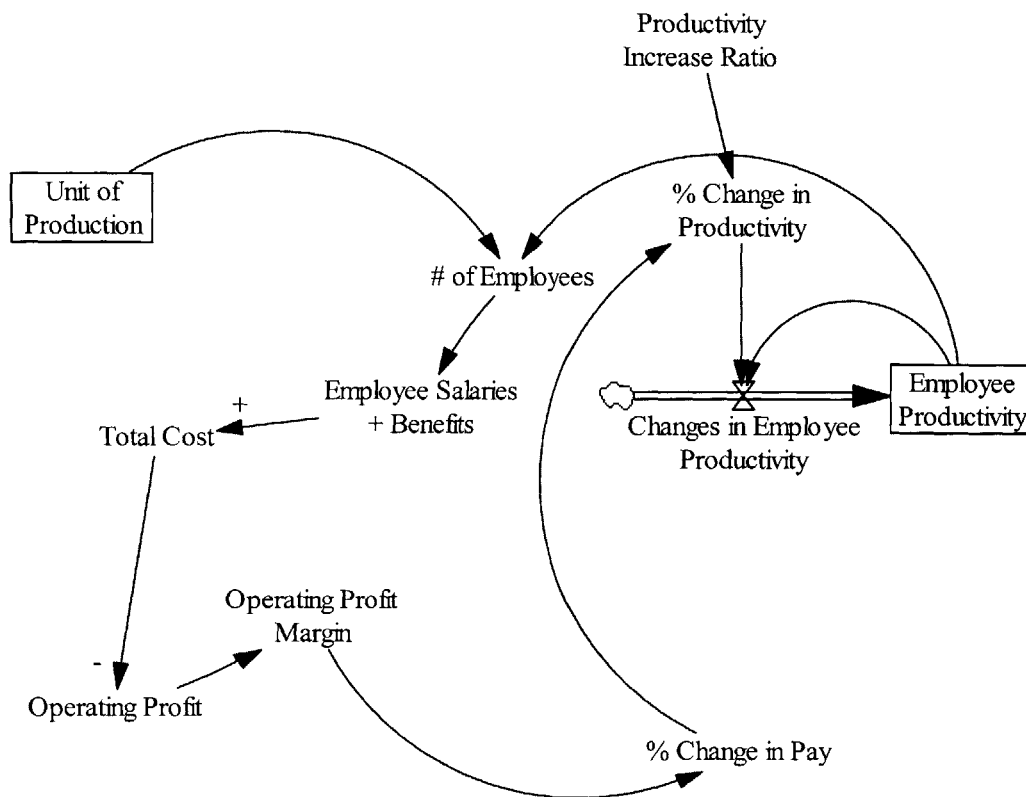
The result of the *Operating Profit Margin* variable is influenced by a balancing loop and a reinforcing loop. The dynamics of this system dynamics model is influenced by the

interaction between balancing and reinforcing loops. In this section, these loops are highlighted.



**Figure 4-9: Balancing Loop**

Employee Pay changes create a balancing loop, illustrated in Figure 4-9. Positive *Operating Profit Margin*, assuming that there is a positive link to *% change in pay*, would lead to increases in *S+B/Employee*. This would in turn lead to increases in *Employee Salaries + Benefits*, as well as increases in *Total Cost*. The final result of this loop is that *Operating Profit* would decrease, balancing the positive *Operating Profit Margin*.



**Figure 4-10: Reinforcing Loop**

On the other hand, employee productivity changes create a reinforcing loop, as illustrated in Figure 4-10. Positive *Operating Profit Margin*, assuming that there is a positive link to *% change in pay*, would lead to increases in *Employee Productivity*. Since the model assumes that ASM stays constant, increases in *Employee Productivity* would result in decreases in *# of Employees*, and finally decreases in *Employee Salaries + Benefits*. Lower employee cost would lead to lower *Total Cost*, so the final result of this loop is that *Operating Profit* increases. The dynamic of changes in *Operating Profit Margin* is influenced by the interaction between the balancing loop and the reinforcing loop.

In summary, the Salaries and Benefits Systems Dynamics Model is designed to simulate the impact of changes in labor pay and productivity on operating profit margin. Labor pay, productivity, and the resulting changes in total cost and profitability, are the only

aspects of the model that are allowed to change. All other variables, such as other cost, unit of production, and revenue, are held constant. This is done to eliminate noise and to allow a system response test.

There are two links in the model that are hypotheses, based on the two assumptions made. Three variables are used to control the hypothesized links; these variables will also be used to describe the different scenarios to be tested. First, the variable *Productivity Increase Ratio* is used to describe the link between pay changes and productivity changes. Secondly, the variable *Pay Increase Ratio* is used to describe the link between profit and pay changes. Finally, a third variable, *Pay Increase Delay*, is used to simulate the delay between profit and pay changes. It is intended to simulate the fact that contract lengths as well as delays in negotiations could put profit and pay changes out of phase.

In the simulation, first the affect of *Productivity Increase Ratio*, *Pay Increase Ratio*, and *Pay Increase Delay* will be tested to ensure the model is providing reasonable behaviors. The results will be presented in Section 4.2, System Response Testing. Next, different levels of *Pay Increase Delay* will be simulated to study the impact on the value of labor contracts. The results will be presented in Section 4.3.



## 4.2 System Response Testing

In this section, different values of *Pay Increase Ratio*, *Productivity Increase Ratio*, and *Pay Increase Delay* are tested to study the system response based on this system dynamics model. The main purpose of system response testing is to ensure that the model behavior is reasonable. Only parameters affected by changes to these input values will be changed; all other parameters will stay constant. Each time frame in the simulation corresponds to one quarter. At time 0, the airline makes a steady-state *Operating Profit Margin* of 5%.

The system response testing experiments are separated into 3 groups.

Group 1 tests the effect of different *Pay Increase Ratio*:

Case Number	<i>Pay Increase Ratio</i>	<i>Productivity Increase Ratio</i>	<i>Pay Increase Delay</i>
Base Case	0	0.7	N/A
Case 1	0.5	0.7	N/A
Case 2	1	0.7	N/A

**Table 4-1: Group 1 Simulation Input Parameters**

At an operating profit margin of 5%, *Pay Increase Ratio* of 1 corresponds to 20% pay raises per year. It is extremely high but not unrealistic. For example, in the summer of 2000, United pilots received 20% or more in pay raises. Group 1 experiments are done to study the effect of increasing pay increase ratio.

Group 2 tests the effect of different *Productivity Increase Ratio*:

Case Number	<i>Pay Increase Ratio</i>	<i>Productivity Increase Ratio</i>	<i>Pay Increase Delay</i>
Case 3	0.5	0	N/A
Case 4	0.5	0.1	N/A
Case 5	0.5	0.7	N/A
Case 6	0.5	1	N/A
Case 7	0.5	1.2	N/A

**Table 4-2: Group 2 Simulation Input Parameters**

A range of different values for *Productivity Increase Ratio* is tested. Group 2 experiments examine the effect of increasing *Productivity Increase Ratio*.

Group 3 tests the effect of different *Pay Increase Delay*:

Case Number	<i>Pay Increase Ratio</i>	<i>Productivity Increase Ratio</i>	<i>Pay Increase Delay</i>
Case 8	0.5	0.7	0
Case 9	0.5	0.7	4 quarters (1 yr)
Case 10	0.5	0.7	8 quarters (2 yrs)
Case 11	0.5	0.7	12 quarters (3 yrs)
Case 12	1	0.05	12 quarters (3 yrs)

**Table 4-3: Group 3 Simulation Input Parameters**

The impact of increasing lengths of time delay on profit and pay increases is studied in Cases 8-11. Typical contract lengths may be 3 years or more, and it could take a year or more to reach an agreement. In Case 12, the researcher intentionally increases *Pay Increase Ratio* and decreases *Productivity Increase Ratio* to exaggerate the effects of *Pay Increase Delay*.

### Group 1 Results:

The focus of Group 1 tests is to study the impact of increasing *Pay Increase Ratio*.

Case Number	<i>Pay Increase Ratio</i>	<i>Productivity Increase Ratio</i>	<i>Pay Increase Delay</i>
Base Case	0	0.7	N/A
Case 1	0.5	0.7	N/A
Case 2	1	0.7	N/A

Table 4-4: Group 1 Simulation Input Parameters

### Group 1 - Operating Profit Margin

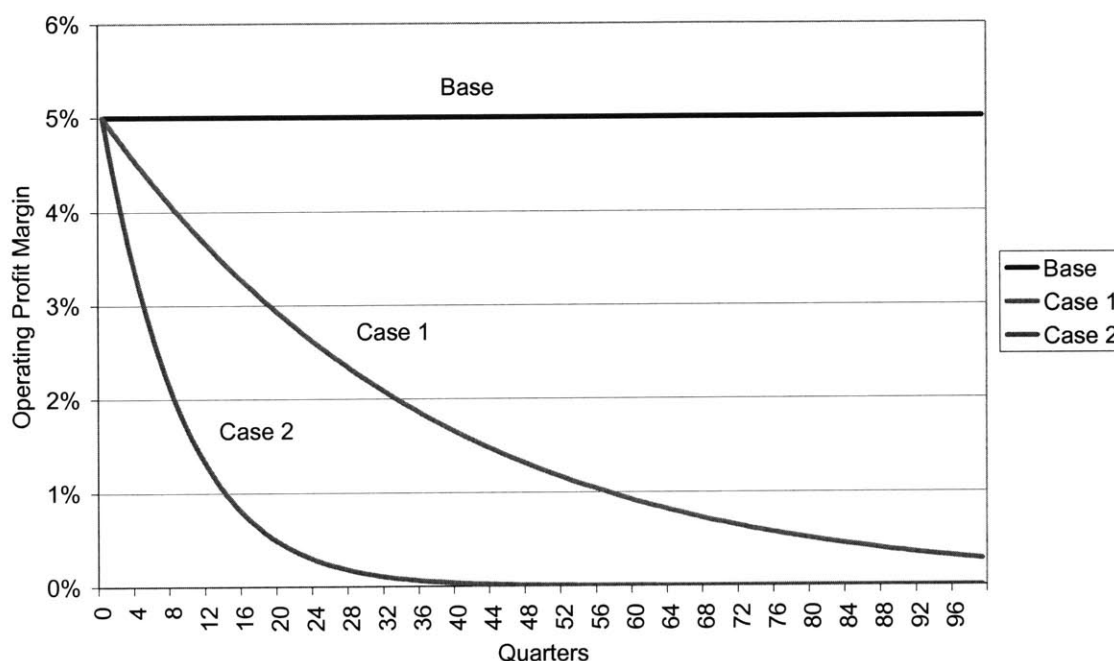
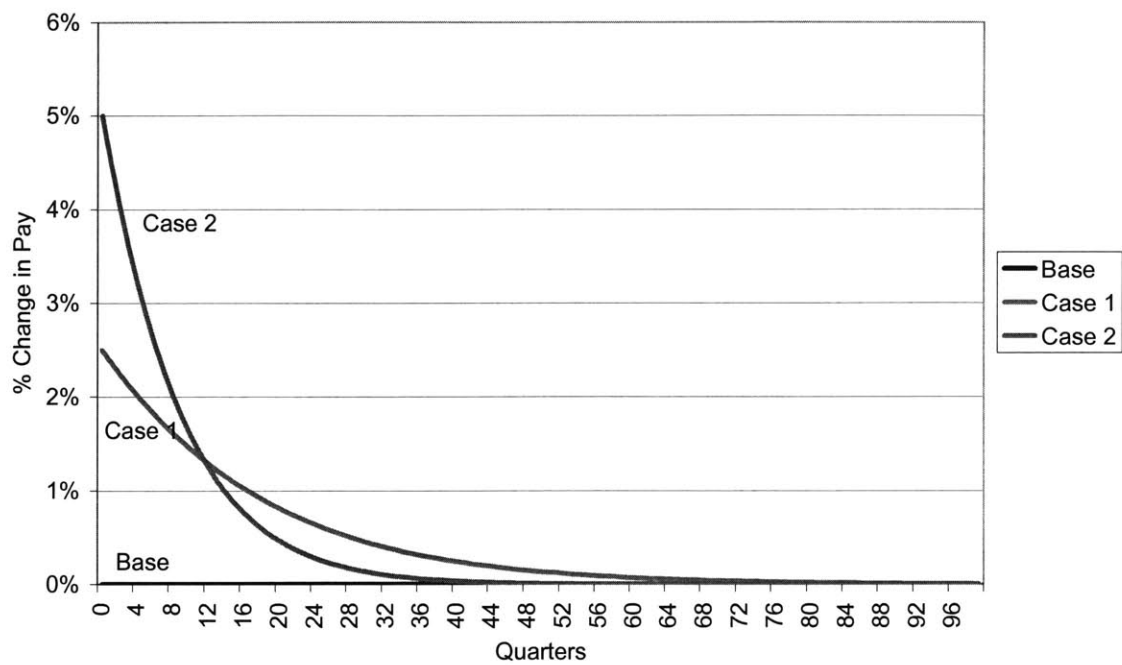
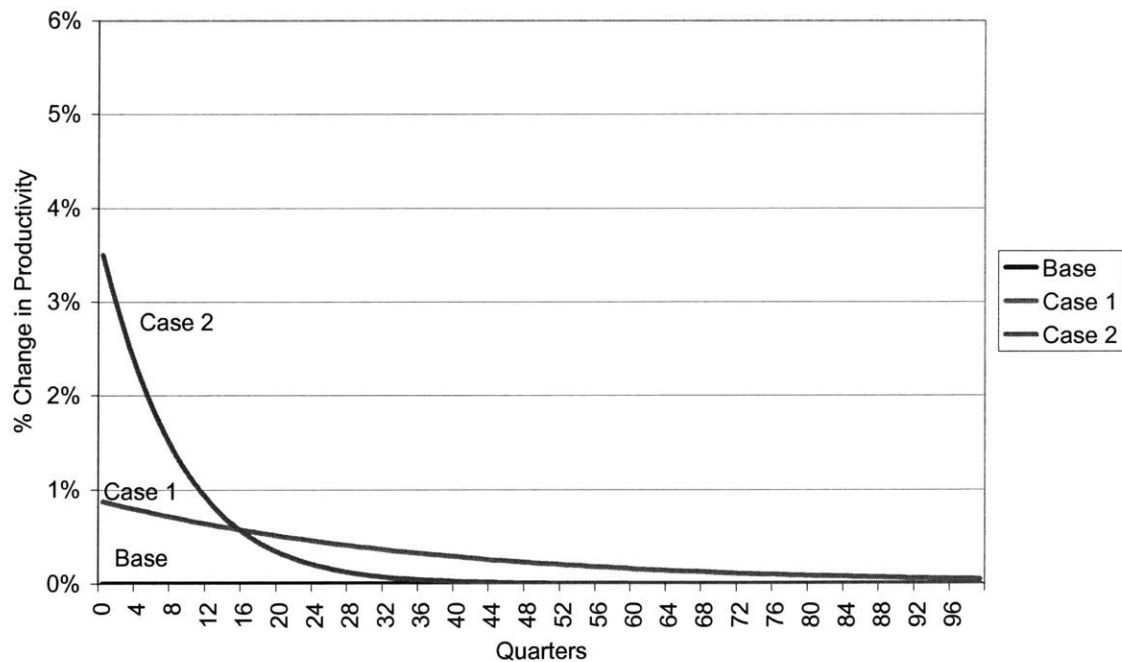


Figure 4-11: Operating Profit Margin with Increasing *Pay Increase Ratio*

As *Pay Increase Ratio* increases, labor receives a larger pay increase in a shorter amount of time. As a result, *Operating Profit Margin* declines faster. As *Operating Profit Margin* declines, pay increase declines as well. Therefore, higher *Pay Increase Ratio* leads to a sharper decline in pay increase. *Pay Increase Ratio* acts as a “gain” in the system. The system response behavior to changing *Pay Increase Ratio* is reasonable.

**Group 1 - Percent Change in Pay****Figure 4-12: Percent Change in Pay with Increasing *Pay Increase Ratio*****Group 1 - Percent Change in Productivity****Figure 4-13: Percent Change in Productivity with Increasing *Pay Increase Ratio***

Group 2 test results:

Case Number	<i>Pay Increase Ratio</i>	<i>Prod. Inc. Ratio</i>	<i>Pay Increase Delay</i>
Case 3	0.5	0	N/A
Case 4	0.5	0.1	N/A
Case 5	0.5	0.7	N/A
Case 6	0.5	1	N/A
Case 7	0.5	1.2	N/A

Table 4-5: Group 2 Simulation Input Parameters

### Group 2 - Operating Profit Margin

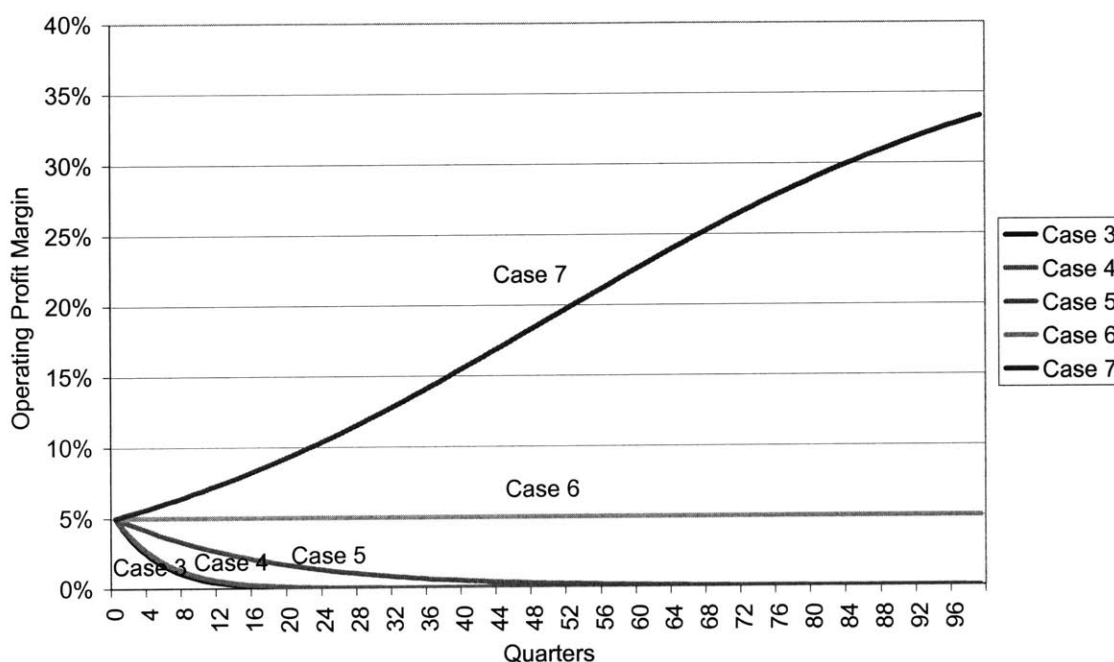
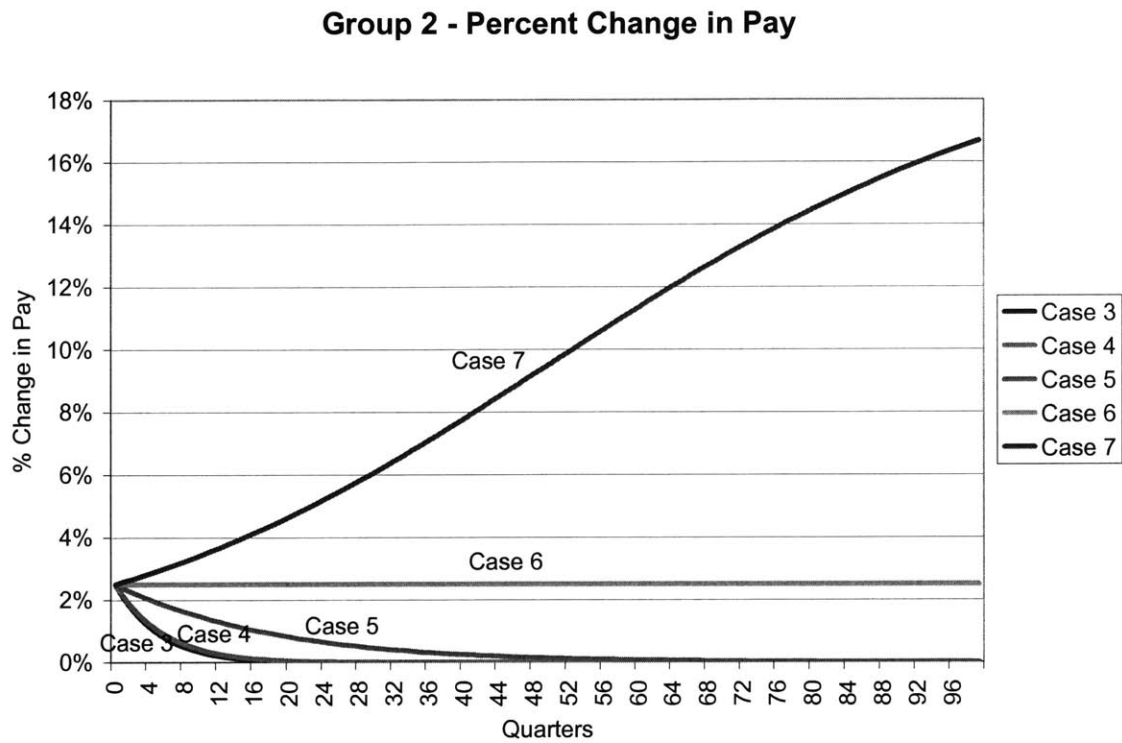


Figure 4-14: Operating Profit Margin with Increasing *Productivity Increase Ratio*

As *Productivity Increase Ratio* increases, *Operating Profit Margin* declines more slowly. At *Productivity Increase Ratio* = 1, any pay increase is offset by any productivity increase, and *Operating Profit Margin* remains constant. For a company to maintain its profit margins, any pay increase has to be offset by the same percentage of productivity increase. In order to improve its margins, *Productivity Increase Ratio* has to be greater than 1. In this simulation, *Operating Profit Margin* asymptotically approaches about

40%. This is due to the unrealistic case of labor productivity increasing to the point of labor cost being driven to zero.



**Figure 4-15: Percent Change in Pay with Increasing *Productivity Increase Ratio***

### Group 2 - Percent Change in Productivity

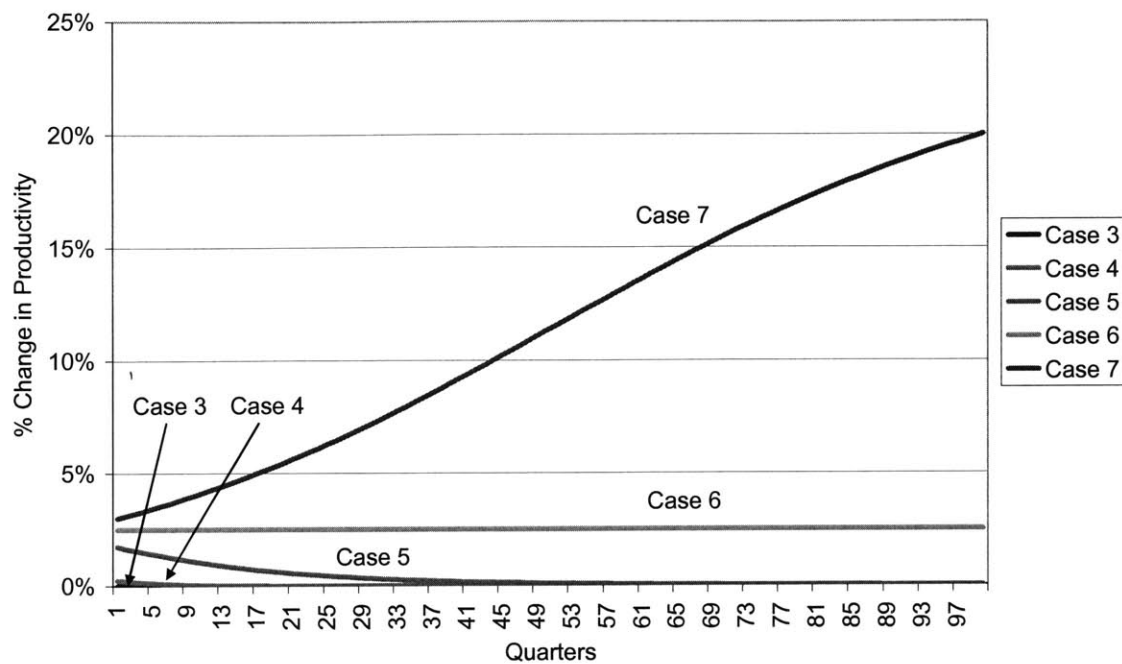
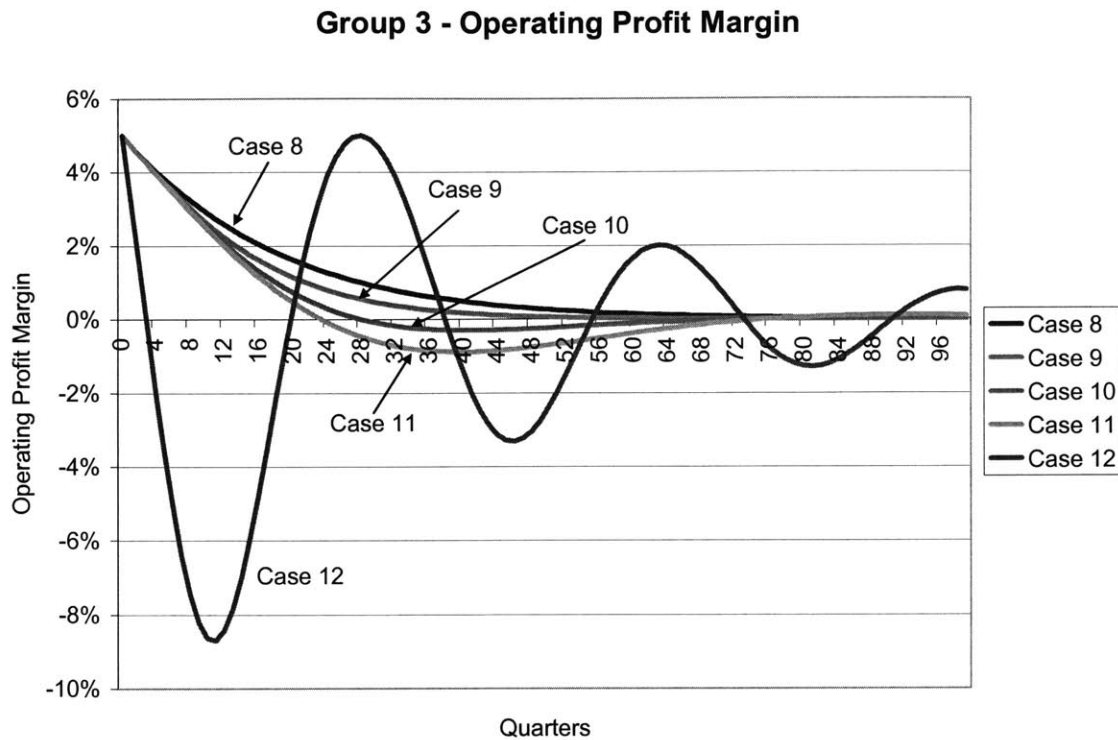


Figure 4-16: Percent Change in Productivity with Increasing *Productivity Increase Ratio*

Group 3 test results:

Case Number	<i>Pay Increase Ratio</i>	<i>Productivity, Inc. Ratio</i>	<i>Pay Increase Delay</i>
Case 8	0.5	0.7	0
Case 9	0.5	0.7	4 quarters (1 yr)
Case 10	0.5	0.7	8 quarters (2 yrs)
Case 11	0.5	0.7	12 quarters (3 yrs)
Case 12	1	0.05	12 quarters (3 yrs)

Table 4-6: Group 3 Simulation Input Parameters



**Figure 4-17: Operating Profit Margin with Increasing *Pay Increase Delay***

As *Pay Increase Delay* increases from zero, *Operating Profit Margin* starts to exhibit oscillatory behavior. In Cases 10 and 11, *Operating Profit Margin* could reach a negative value. With a *Pay Increase Delay* of 2 years and more, pay and profit was out of phase, and the company will be forced to ask labor for a pay cut in order to remain profitable. In Case 12, *Pay Increase Ratio*, which acts as gain, is increased to a large value, while *Productivity Increase Ratio*, which acts as damping, is decreased to a small value. The result is that the system exhibits strong oscillatory behavior. *Operating Profit Margin* reached almost -9% before recovering. Labor could be asked to give up 3% of their pay per quarter, or 12% per year. It is obvious that strong oscillator behavior is undesirable for both labor pay and company profitability.



### Group 3 - Percent Change in Pay

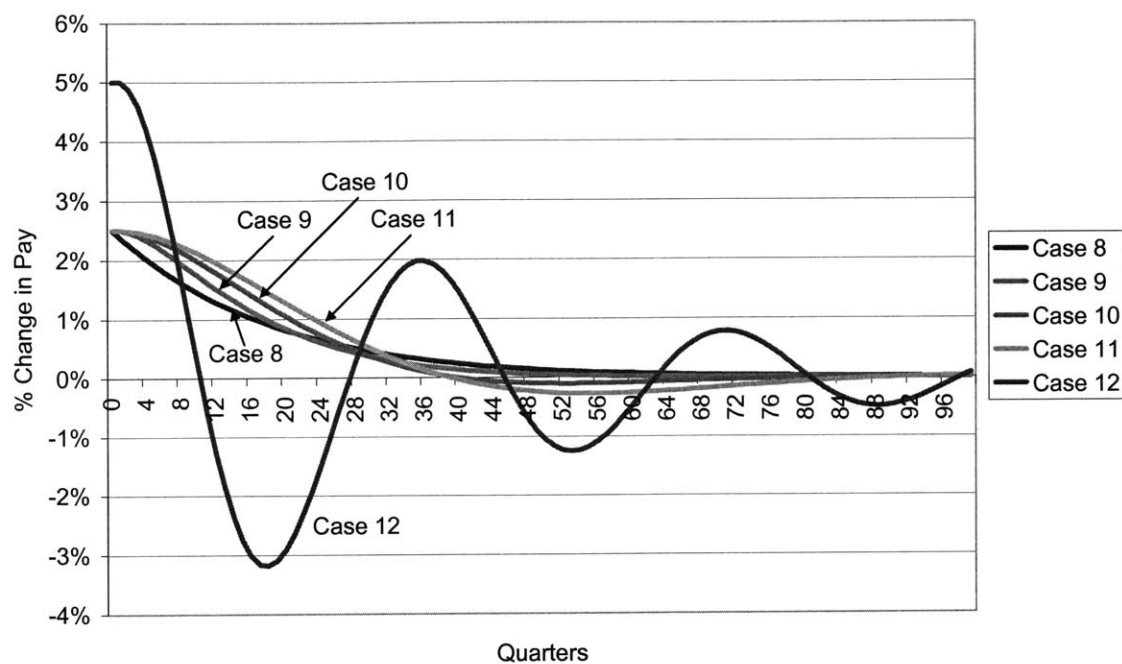


Figure 4-18: Percent Change in Pay with Increasing *Pay Increase Delay*

### Group 3 - Percent Change in Productivity

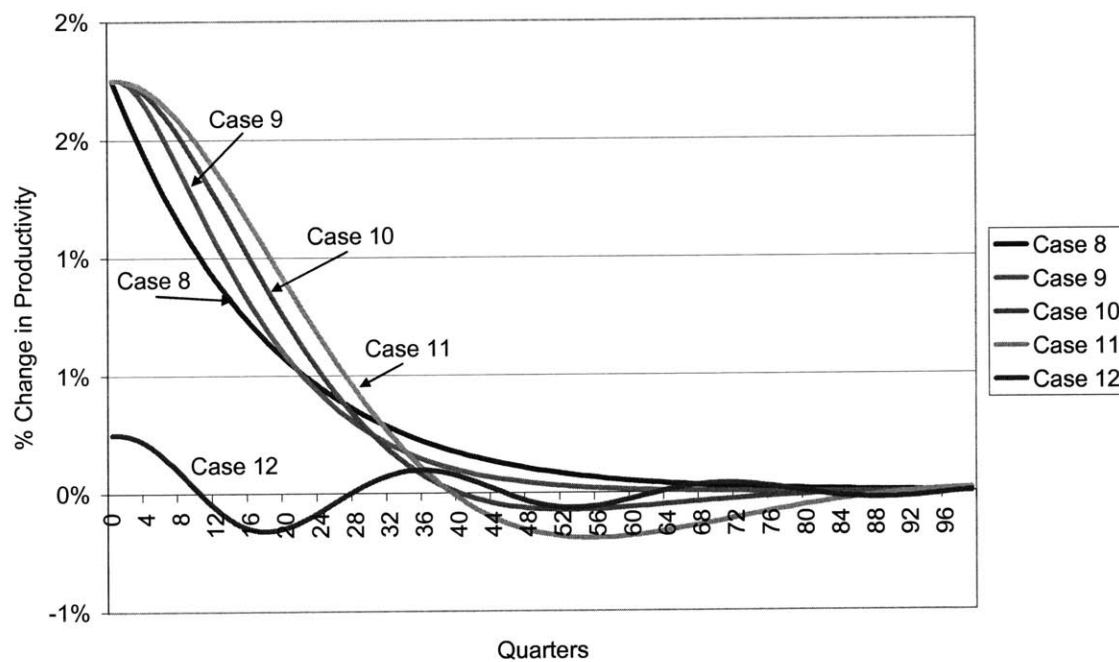


Figure 4-19: Percent Change in Productivity with Increasing *Pay Increase Delay*

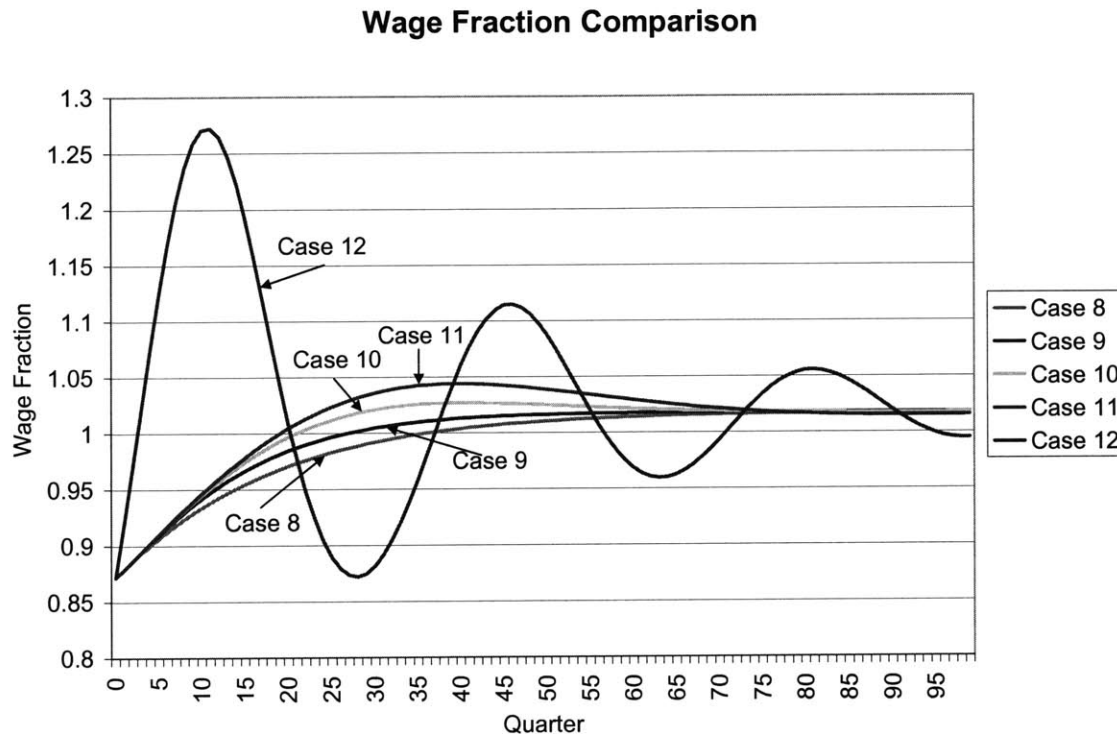
### 4.3 Results and Implications on the Value of Labor Contracts

This is a summary of the system response testing results, when a time delay is introduced into the system. The time delay simulated is the time delay between *Operating Profit Margin* and *Pay Increase Ratio*.

- When there is a delay between profit margin and pay raise, oscillation occurs. The bigger the pay increase delay, the higher the oscillation amplitude and period.
- Reducing the time delay between profitability and pay increase is beneficial to both labor and management. It could stabilize the system response and reduce overshoot.
- During lean times, union groups should realize that their salaries have to be reduced in order to pull profitability toward positive.

One real world example of the effect of pay increase delay is the case of United Airlines during the late 1990s and early 2000s. What happened to United's employee pay and profitability shows that the model behavior is reasonable. United earned record profits during the late 1990s, but due to union contracts as a result of their employee ownership plan, employee salaries were not increased. By 2000, the pilot union demanded a share of the profit, and secured a very large pay increase. Over the next year, other unions at United wanted similar pay increases as well. In the mean time, the economy started to worsen, and lower revenue, coupled with higher cost, led to large losses. When United started losing money, some of its unions still demanded pay increases because their colleagues at other unions received large pay increases. This is an example of how pay increase delay could cause overshoot in negative profitability. After the events of September 11<sup>th</sup>, the airline asked all its unions for a pay reduction. Some unions refused to give concessions, partly because of the large pay increase delay a few years back. Without a reduction in pay, the airline was still suffering from high costs. Since the demand was greatly reduced after September 11<sup>th</sup>, without cutting labor costs, United had a very difficult time achieving profitability. All of this is partly the result of the fact that a large pay increase delay caused pay increases to be out of phase with the underlying revenue environment, leading to large overshoot in negative profitability.

So far it has been established that delays between profitability and pay causes oscillatory behavior in profitability and pay. In this section, this researcher seeks the answer to the original key question and looks at the impact on the value of labor contracts. In Figure 4-20, the results for *Wage Fraction* were generated using the same 5 input scenarios - Case 8-12.



**Figure 4-20: Wage Fraction Comparison, Increasing Pay Increase Delay**

Recall that the *Pay Increase Delay* was 0 years in Case 8, increasing to 3 years in Case 11. In Case 12, *Productivity Increase Ratio* was reduced, resulting in reduced damping and increased oscillation. The *Wage Fraction* at Quarter 0 was at 0.875. The assumptions in the model lead the operating profit of the company to asymptotically approach 0, and as a result, the value of *Wage Fraction* asymptotically approaches 1. Due to round-up errors used in the simulation, the simulated wage fraction asymptotically approaches a value slightly greater than 1. This does not have a large impact on the analysis, however.

As *Pay Increase Delay* increases, the peak value for *Wage Fraction* increases as well. The larger the *Pay Increase Delay*, the larger the overshoot in *Wage Fraction*. In Case 12 with large *Pay Increase Delay* and low *Productivity Increase Ratio*, the oscillation amplitude is large, and the magnitude of the overshoot is significant.

In Figures 4-21 and 4-22, *Wage Fraction* and the resulting value of the labor contract is presented. Figure 4-22 is the same graph as 4-21 but with *Wage Fraction* displayed from 0.8 to 1.1. For the LCVC shown, volatility ( $\sigma/\mu$ ) was 0.29,  $\rho$  was 0.28, and  $S_{mkt}$  was 0.70. The revenue condition was taken from an anonymous company in 2000.

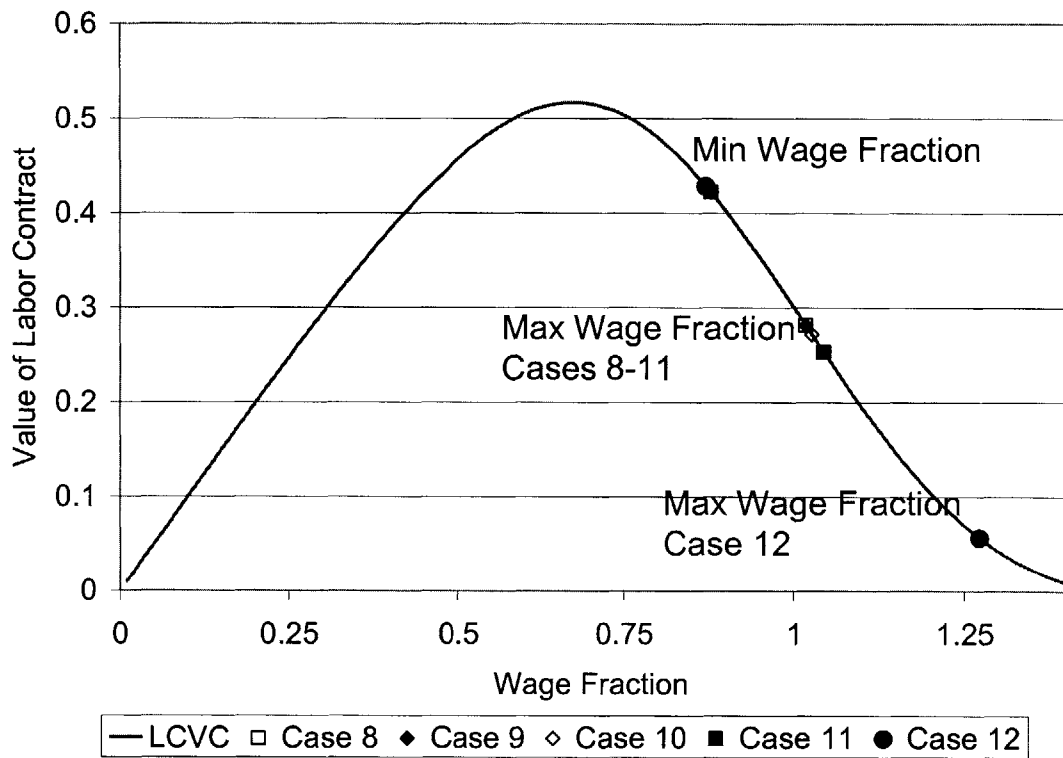
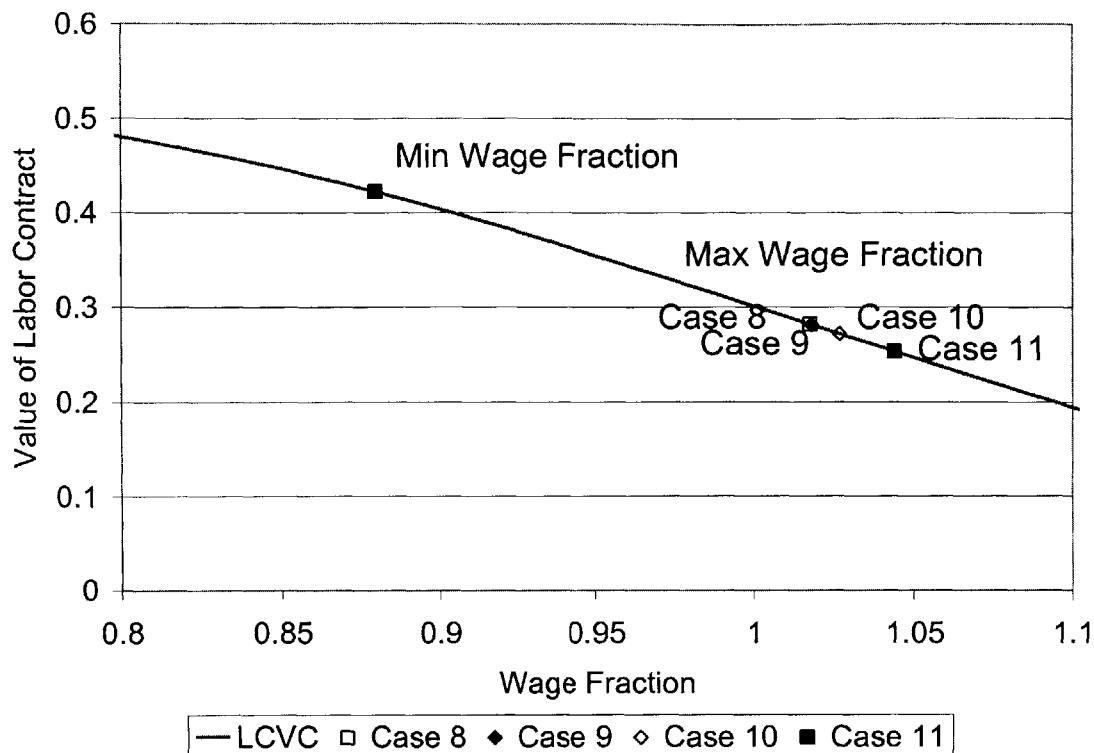


Figure 4-21: Value of the Labor Contract, Increasing *Pay Increase Delay*



**Figure 4-22: Value of the Labor Contract, Increasing *Pay Increase Delay***

For this company in 2000, *Optimum Wage Fraction* would have been 0.7, and maximum normalized value of labor contract would have been 0.517. Under the initial condition, the company was operating at an actual *Wage Fraction* of 0.88, resulting in a normalized value of labor contract of 0.423.

With Case 8 and Case 9, there was no overshoot in the value of *Wage Fraction*. As a result, minimum normalized value of labor contract was the steady-state value of 0.28. For Case 10 and Case 11, *Wage Fraction* overshoot to 1.03 and 1.04, respectively, and minimum normalized value of labor contract was 0.27 and 0.25 respectively. In Case 12, a strong oscillatory behavior was observed. In fact, minimum *Wage Fraction* was lower than the initial condition at 0.87, but maximum *Wage Fraction* was much larger than all other cases, at 1.27. As a result, maximum normalized value of labor contract was 0.429, but minimum normalized value of labor contract was 0.057.

As the shape of the LCVC is concave, and the drop in value past *Optimum Wage Fraction* is significant, it is undesirable for *Wage Fraction* to oscillate, and overshoot the steady-state solution.

Therefore, to answer the key question:

- 4) When the labor contract value is at its peak, how could the time delay between profit and changes in pay affect the value of the labor contract?

Time delay between profit and changes in pay causes overshoot and oscillator behavior in *Wage Fraction*. As *Wage Fraction* is increased past *Optimum Wage Fraction*, the shape of the LCVCs suggests that the normalized value of the labor contract drops significantly. Therefore, time delay between profit and changes in pay has a significant negative effect on the value of the labor contract. It is in the interest of labor to shorten this time delay to avoid the large drop in labor contract value. It is also in the interest of management to shorten this time delay to avoid the negative impact on profitability. Methodology that would allow the time delay to be shortened includes shorter negotiations, as well as tying compensation to profitability. Revenue sharing and profit sharing are examples of tying compensation to profitability. Therefore, the implementation of such schemes could be beneficial to the value of labor contracts.

## CHAPTER 5

# THE CASE OF THE US AIRLINE INDUSTRY

In this chapter, a case study of the application of the analysis for labor contract valuation is presented. The industry chosen for the case study is the US airline industry. The majority of the US major airlines (abbreviated to “US Majors”) are unionized, but they are facing increasing competition from non-unionized, start-up carriers with lower operating costs. The airline industry is an industry for which the application of the analysis presented in this thesis may be beneficial to various stakeholders.

In Section 5.1, some background information about the US Majors will be introduced. This will be followed by Section 5.2 with a look at some previous research in the area of airline labor cost. In Section 5.3, the status of US Majors will be discussed. For each airline, the *Labor Contract Value Curve* (LCVC) and *Wage Fraction* will be calculated. In Section 5.4, Labor contract value comparison between labor groups will be performed. In Section 5.5, post 9/11 results will be discussed, and a discussion of difficulties in adopting this analysis to real world data will be presented. Finally, this section concludes with a summary in Section 5.6.

## **5.1 US Airline Industry Background**

### **5.1.1 Airline Profitability**

In 1978, the United States Congress passed the Airline Deregulation Act. This act represented a significant change in the way US-based airlines were managed and operated (Kahn, 1988).

Prior to deregulation, the Civil Aeronautics Board (CAB) governed operations of interstate carriers. Many aspects of an airline's operation, such as route authority and fare levels, were regulated. For example:

- Route authority was regulated, so no new airlines could enter the marketplace. This resulted in the elimination of competition from lower cost new entrant airlines.
- Fare levels were regulated, so airlines competing on the same routes could not compete on price.

Without competition from lower cost new entrant airlines, and without the ability to compete on price on a given route, the incumbent airlines had little incentive to control costs. Furthermore, if an airline faced financial trouble, the airline could request the CAB to raise fares to ensure profitability, or the CAB would encourage the carrier to merge with a financially healthier airline. As a result, incumbent airlines entered deregulation with high costs.

The Airline Deregulation Act of 1978 removed route authority and fare controls, allowing new entrant carriers to compete with incumbents on any route they wished to fly, and incumbent carriers to enter other routes for which they did not previously have route authority. The result of removal of route authority control was more competition in the marketplace. With the removal of fare controls, market forces became the dominant mechanism for setting fares. Thus, established carriers no longer had the option of raising fares in order to compensate for their high costs. Additionally, new entrant carriers were not burdened by a senior and expensive work force. Their costs were lower, and thus they were able to charge a lower fare. However, new entrants did not



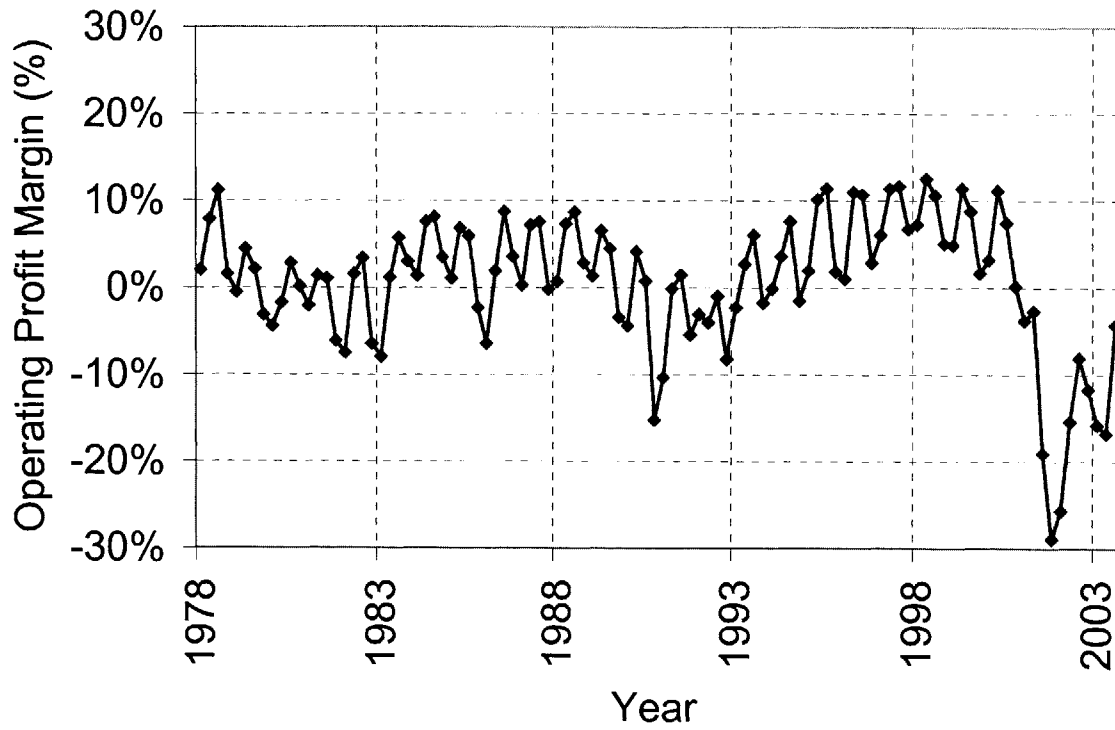
have the deep pockets of incumbents, and were ill prepared for the intense competition that followed. Because the financial stability for a carrier was no longer assured, the period has been marked by mergers and bankruptcies of both incumbents and new entrant carriers.

Because of the competitive nature of the US airline industry since deregulation, and the challenge from low-cost new entrant carriers, operating profit margins in the US airline industry has been very low. In Figure 5-1, the operating profit margin of the US Majors overall between deregulation in 1978 and 2003 is shown. The US Department of Transportation (DOT) defines a Major carrier as an airline with annual revenue of greater than one billion US dollars. In 2000, US Majors include, in alphabetical order of their IATA (International Air Transport Association) airline code, American Airlines (AA), Alaska Airlines (AS), Continental Airlines (CO), Delta Airlines (DL), America West Airlines (HP), Northwest Airlines (NW), Trans World Airways (TW), United Airlines (UA), USAirways (US), and Southwest Airlines (WN). For the rest of this thesis, US Majors refer to these ten airlines.

The US Majors together could only achieve an annual operating profit margin of 7 or 8% in an economic expansion. When the economy is not doing well, the majors together may even achieve a negative operating margin, such as in 1991 and 2001-03. The US economy was in recession during the early 1980s, the early 1990s, and the early 2000s. Operating profit margin of US Majors followed the cyclicity of the US economy with the worst margins during economic recessions. The poor operating profit margin, as well as the cyclicity, experienced by US Majors, is exhibited in Figure 5-1.

Furthermore, even within a year, the operating profit margin is strongly affected by seasonal demand. For any given year, the difference in operating profit margin between the most profitable quarter and the least profitable quarter could be 10% or more. While the seasonality difference is not as great as some other industries, such as the retail industry, seasonality still poses a large challenge to airlines. The seasonality effect

coupled with low overall profitability presents a serious challenge facing the airline industry.



**Figure 5-1: Quarterly Operating Profit Margin of US Major carriers between 1978 and 2003**

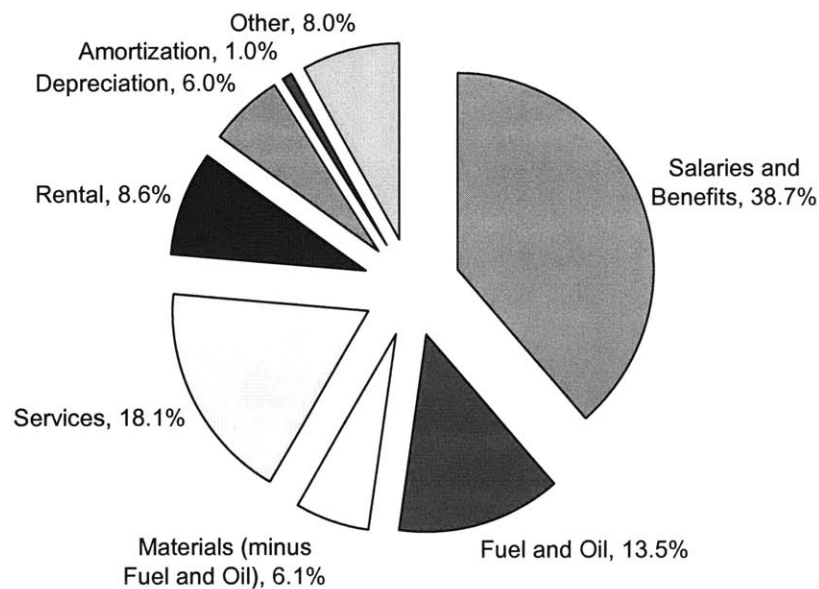
For the year 2002, US Major carriers together achieved an operating profit margin of negative 12.61%. In the same year, the 30 companies which comprise the Dow Jones Industrial Index together had a market capitalization weighted average operating profit margin of positive 15.84%. There are four companies in the Dow 30 that have a strong link to the airline industry. While the remaining 26 companies had an average operating profit margin of 17.04%, the four aerospace companies had an average operating profit margin of 10.76%. Of these four, GE is the most diversified company, and showed 13.15% operating profit margin. Without GE, the remaining three companies, Boeing, Honeywell, and United Technologies, together had an operating profit margin of 0.7%. Compared to companies in other industries, US Majors showed lower profitability. The major suppliers to the US airline industry also showed lower profitability.

Compared to international carriers, US Majors also showed inferior profitability. Oum and Yu (1998) performed an analysis of profitability of the world's major airlines. They concluded that, despite the fact that European carriers faced a more rapid rise in input prices and faster decline in fares than North American carriers, they achieved higher growth in profitability since the early 1990s due to their higher productivity growth. Asian carriers had even higher profitability growth than European carriers, and this is also due to even higher productivity growth. North American carriers have lagged behind European and Asian carriers in profitability growth since the recession in the early 1990s. Oum and Yu attributed this difference mainly to higher productivity growth in European and Asian carriers.

In summary, operating profit margin for US Majors exhibited strong cyclical and seasonality. Their combined operating profit margins have been poor compared to companies in other industries. Even suppliers to the US airline industry exhibited poor profitability. Airlines in other parts of the world were able to achieve better profitability growth than US Majors since the recession in the early 90s, mainly through productivity growth. Since US Major airlines have low margin operations, controlling costs and productivity is critical for profitability.

### **5.1.2 Labor Compensation**

The breakdown of total operating costs of US Majors for the year 2001 is shown in Figure 5-2. As shown in the figure, the three largest components of operating costs are : 1) fuel and oil, 2) outside services purchased, and 3) labor. Because airlines operate with a very small operating profit margin, any significant changes in these three components has a large impact on profitability.



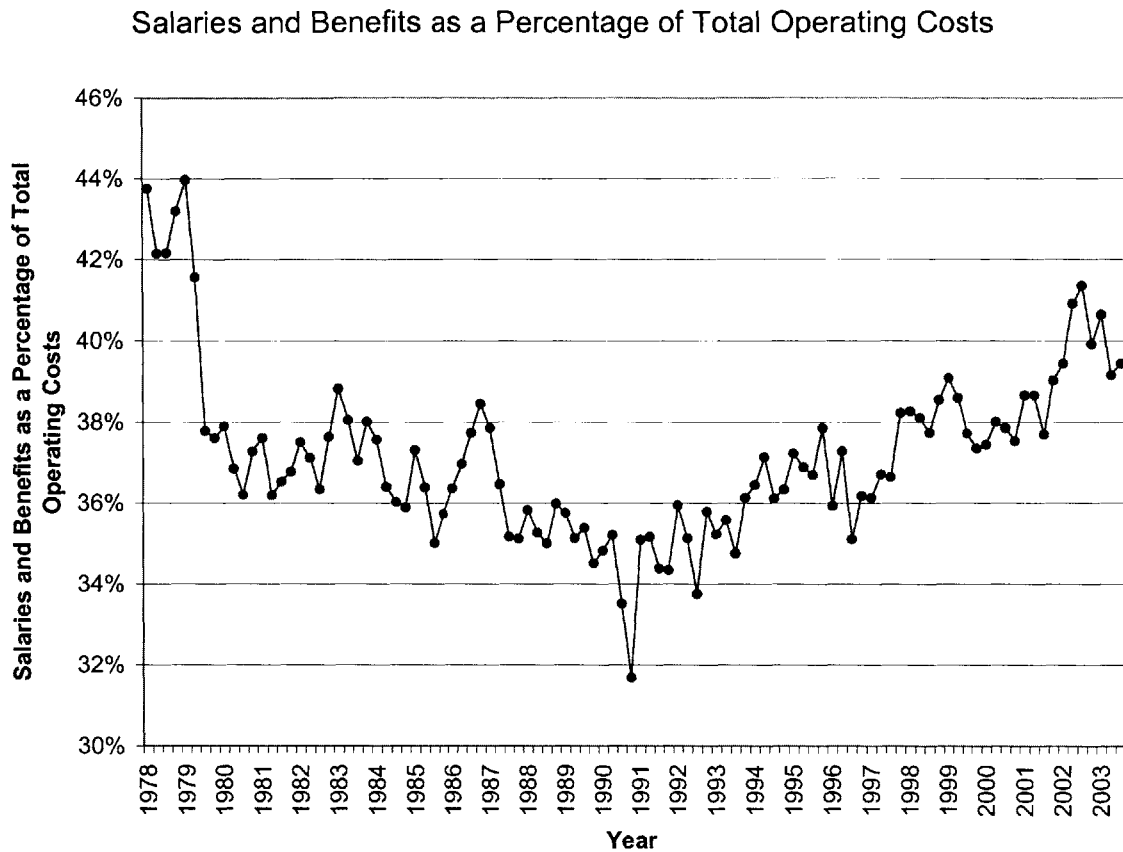
**Figure 5-2: Breakdown of Total Operating Costs, US Majors, 2001**

Fuel and Oil accounted for 13.5% of total operating costs. In the overall global oil market, each individual airline is a small consumer with no ability to influence overall price. Airlines are price takers in the oil market. Their only options to reduce fuel costs are to either operate more fuel efficient aircraft, or to hedge against an increase in fuel prices. Purchasing more fuel efficient aircraft has a positive impact on fuel usage, but has a negative impact on rental, depreciation costs, and debt levels. Hedging protects against fuel price increases, but incurs a cost, and does not actually lower fuel expenses in the long run. Thus, the ability of either action to improve operating profit margin is limited. Since airlines have no ability to negotiate a significant change in their fuel cost, fuel is considered cost of goods sold in this thesis, and will be treated as sunk cost.

Services accounted for 18.1% of total operating costs in 2001. Major elements of the Services category include advertising, insurance, and travel agency commissions. Over the past decade, airlines have strived to reduce costs in this category. For example, they

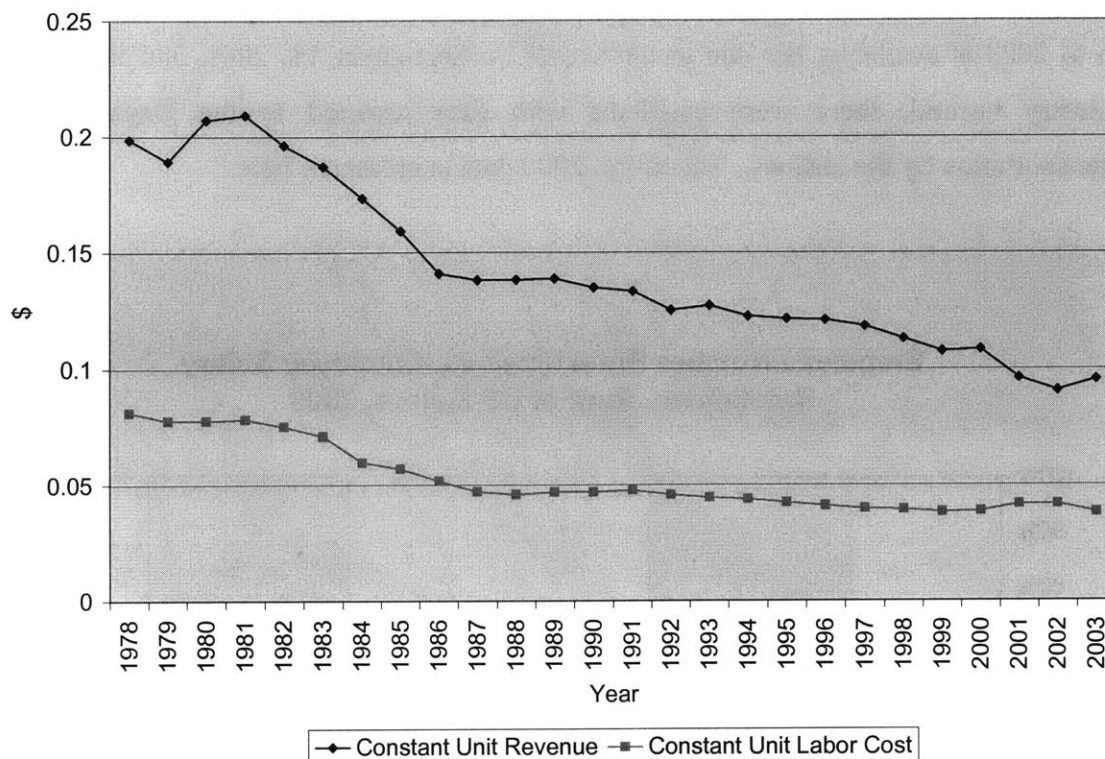
have greatly reduced ticket distribution costs by cutting travel agency commissions. However, insurance cost increased significantly after the events of 9/11. Most US Majors already pay little commission for passenger tickets; the ability to reduce cost in this category is also limited. In this thesis, this cost category is also treated as sunk cost.

The largest component of operating costs is labor expenses. One major difference between labor cost and other cost categories is that labor cost is usually negotiated, while other costs are less negotiable. Between 1978 and 2001, labor costs of the US Majors represented 32 to 44% of the total operating costs. Because labor cost is a significant component of total operating cost, labor cost and labor productivity have a very large impact on profitability. Airlines have a very small operating profit margin, and if labor costs increase substantially, it can easily eliminate the operating profit. As a result, airlines need to pay considerable attention to labor costs. Change in salaries and benefits as a percentage of total operating costs, between the years 1978 and 2001, is illustrated in Figure 5-3. Shortly after deregulation in late 1978, this percentage dropped from 44% to 37.5%, initially due to a large increase in fuel prices. The labor cost percentage continued to decline throughout the next decade, bottoming out at about 35% during the recession in the early 1990s. Since that time, airlines have been profitable through 2000, and salaries and benefits started to slowly increase as a percentage of total operating costs, reaching about 40%. Due to their small operating profit margins, airlines that continue to allow this ratio to rise would further reduce their own profitability. Therefore, union wage negotiations are a critical aspect of airline management.



**Figure 5-3: Salaries and Benefits as a Percentage of Total Operating Costs**

In Figure 5-4, the challenge airlines are facing with labor cost is illustrated further. The Constant Dollar Unit Revenue (Revenue/ASM) vs. Constant Dollar Labor Unit Cost (Salaries & Benefits/ASM) for the US Majors is presented. From deregulation to the end of 2003, Unit Revenue dropped from 20 cents per ASM to 9.5 cents per ASM. At the same time, labor unit cost dropped from 8.1 cents per ASM to 3.8 cents per ASM. Between 1986 and 2003, Unit Revenue dropped from 14.1 cents to 9.5 cents, a 33% decline, while labor unit cost dropped from 5.2 cents to 3.8 cents, a 27% decline. Even though labor would rather not receive lower wages over time, the challenge the airlines are facing is how to remain a viable business with declining Unit Revenues. Airlines have been able to reduce cost in other areas, but labor cost has not declined in the same proportion as Unit Revenue.



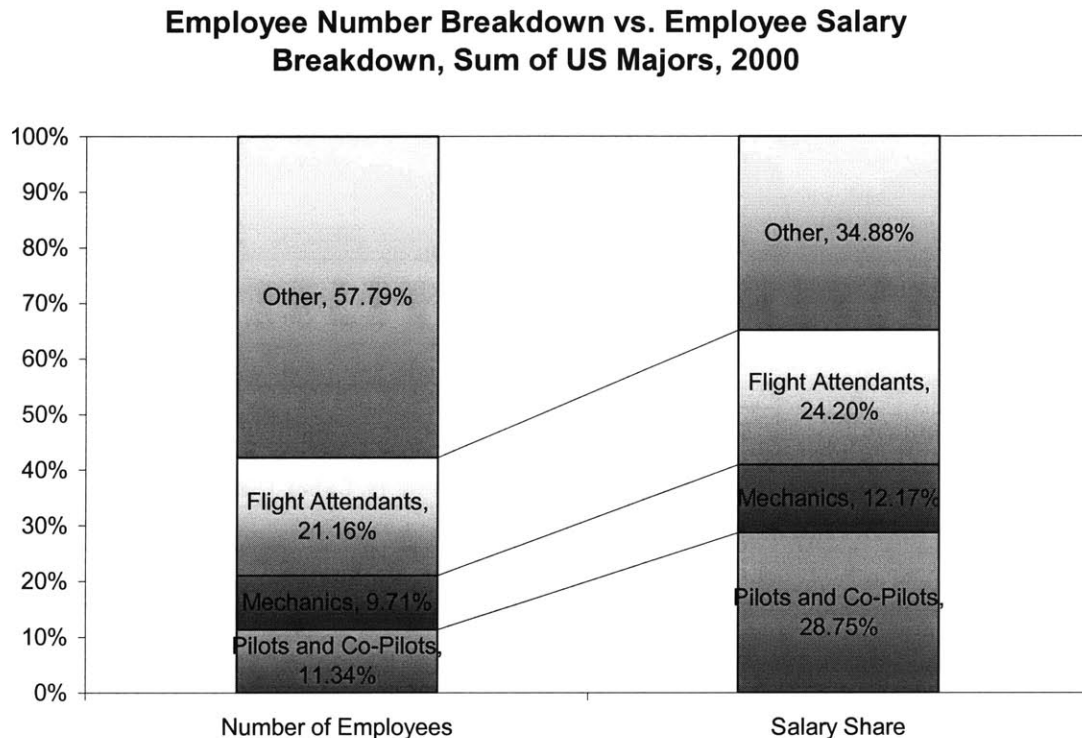
**Figure 5-4: Constant Dollar, Unit Revenue vs. Labor Unit Cost**

The combination of cyclical and seasonal demand, increasing competition, high cost of goods sold, and declining Unit Revenues, makes the airline industry a very challenging industry for all stakeholders. It makes the airline industry an interesting industry for applying the labor contract valuation analysis. It is hoped that the analysis performed in this study could be of some help to all stakeholders.

### **5.1.3 Comparison of Labor Compensation between Different Airline Employee Groups**

Another element worth investigating is the relative labor contract valuation among different union groups. In this section, employee group average salary comparison is presented.

The number and salary breakdown by employee group is shown in Figure 5-5. Later data up to 2003 is available, but due to the events on September 11, 2001, and the ensuing industry turmoil, there were problems with data reported to the Department of Transportation by the airlines. Therefore, 2000 data is presented here.



**Figure 5-5: Employee Number Breakdown vs. Employee Salary Breakdown, Sum of US Majors, 2000**

In 2000, Pilots and co-pilots represented 11% of all employees in US Major airlines, but their salaries represented 29% of all employee salaries. Mechanics represented 10% of all employees, and their salaries represented 12% of all employee salaries. Flight attendants represented 21% of all employees, and their salaries represented 24% of all employee salaries. Together, these three employee groups represented 42% of all employees, but 65% of employee salaries. The numbers presented here are calculated by the author using DOT Form 41 data.



It is interesting to note that pilots were only 11% of the employee population, but they received 29% of the pay. In 2000, the average salary and benefits of pilots at US Majors was \$138,142. The average flight attendant's salary and benefits was \$62,337, and the average mechanic's salary and benefits was \$68,346. Pilots on average receive more than twice the pay of flight attendants and mechanics. This fact raises an interesting question as to how such a large difference in average salaries could be reflected when comparing labor contract value.

#### **5.1.4 Summary of Challenges Facing the Airline Industry**

To summarize, as noted so far in this chapter, US Majors have low operating profit margins, as well as cyclical and seasonality in their demand and profit. In order to maintain profitability and therefore long term survivability of the company, it is important for them to study the impact of all revenue and cost components. To improve profitability, an airline has to either increase revenues, or decrease cost.

It is difficult for an airline to be able to increase their revenue. Pricing is largely driven by market forces, which is in turn driven by demand and competition. Individual airlines have little ability to control pricing and revenue. Airlines have to act as price takers due to competition.

As for decreasing costs, the focus ought to be on the largest cost components. The reason is that any cost reductions in the largest cost components would have the largest impact on profitability. The three largest cost components for an airline are fuel, services, and labor. For fuel, airlines are also price takers, so there are limited opportunities to reduce fuel costs. For services, airlines have already reduced distribution costs significantly. However, airlines are still constrained by increasing insurance costs post-9/11. Therefore, fuel and services costs for airlines are not easily reducible, and should be considered cost of goods sold. On the other hand, the largest cost component is labor cost, and this component is unique in that it is usually negotiated. This is the reason why airlines have approached labor when there is a need to reduce costs.

The analysis presented in Chapter 3 assumes all costs other than labor as sunk cost. This analysis approach, therefore, is suitable for analyzing revenue distribution between labor, in the form of salaries and benefits, and ownership, in the form of profits, for the airline industry. The value of labor contract analysis will be applied to the US Majors, and the results will be presented in Section 5.3.

Also, in a typical airline, employees are represented by various unions according to their craft. Each union usually negotiates separate contracts with the airline. As illustrated earlier in this section, the difference in pay among the various labor groups is large. Analysis presented in Chapter 3 could also be used to compare labor contract value among the various labor groups. The results of this analysis will be presented in Section 5.4.

It is important to note that the analysis presented in this thesis are results based on models. As with any model, there are various assumptions that have to be made. In this thesis, attempts will be made to clarify what the assumptions are, and what the implications may be. The results presented here should be considered in the context of a model with its associated assumptions, and could potentially provide useful insights for both labor and management.

## **5.2 Previous Work in the Area of Airline Labor Cost**

Previous researchers have studied labor cost issues in the US Airline industry. A large number of researches have focused on the areas of labor rent, unionization, and effects of deregulation. In this section, a selection of these papers is presented. Its purpose is to provide readers a better understanding of the historical background surrounding labor cost in the airline industry.

### 5.2.1 Airline Labor Rent

Research by Thornicroft (1989) and Hirsch & MacPherson (2000) has shown that the employees at US Majors earn a statistically significant pay premium over comparable employees in other industries. Thornicroft also observed that the magnitude of this pay premium is not equally distributed among various labor groups in the airline. In this Section, previous research on the reason behind this pay premium will be discussed. Furthermore, issues as a result of the pay premium and premium inequality will be raised.

Hirsch & MacPherson (2000) defined labor rent as the following: Payments to labor beyond long-run opportunity costs. They concluded that labor can extract rent, and labor rents are attributable largely to union bargaining power, which is in turn constrained by the financial health of carriers. They suggested that if substantial rents exist, then airlines may have the opportunity to increase profitability and lower prices through reductions in employee compensation.

Hirsch & MacPherson (2000) went on to analyze labor rent, or labor pay premium, compared to employees with comparable jobs in other industries. Compensation for doing similar jobs in other industries could represent long-run opportunity costs, so any pay premium above that is labor rent. The summary of their findings is shown in Table 5-1:

	Employee Share	1973-1978	1981-1983	1994-1997
Pilots	11%	40.3%	54.5%	36.4%
Flight Attendants	11%	40.1%	45.3%	13.9%
Mechanics	15%	16.5%	19.5%	16.9%
Ramp Workers	9%	3.6%	14.1%	4.9%
Ticket Agents	18%	26.9%	36.7%	10.7%
Others	36%	13.5%	20.1%	6.4%
Overall		21.6%	29.5%	13.1%

**Table 5-1: Airline Employee Pay Premium by Hirsch & MacPherson**

For pilots, the authors used military pilots as the basis for comparison. For Flight attendants, the authors used general sales, administration and service occupations as the

basis for comparison. For Mechanics, the authors used full time mechanics outside of the airline industry as the basis for comparison.

The authors concluded that there is a sizable labor rent to airline employees. The size of the premium ranges from 21.6% prior to deregulation, to 29.5% shortly after deregulation, and finally to 13.1% in 1997. Even though the airline pay premium is falling, airline employees are still paid more than their long-run opportunity cost. Finally the authors noted that since 1997, relative earnings of airline employees were on the rise again compared to comparable jobs in other industries.

As a result of this labor rent, Hirsch & MacPherson (2000) suggested that if relative airline labor costs are to decline further, it must come from concessions among pilots, flight attendants and mechanics. This is because these three labor groups still enjoy the highest labor rent. However, these labor groups are also crafts where union bargaining power is still strong.

A similar study by Thornicroft (1989) also looked at airline employee pay premium over comparable jobs in other industries. For the year 1980, Thornicroft found that airline pilots enjoy a pay premium of 59% over Navy pilots, airline mechanics enjoy a 28% pay premium over auto mechanics, and flight attendants saw no pay premium over teachers and nurses. Note that compared to the study done by Hirsch & MacPherson, Thornicroft compared flight attendant pay to teachers and nurses instead of general sales, administration and service occupations. This explains why Hirsch & MacPherson found a pay premium for flight attendants, while Thornicroft did not. However, the main point to note is that Thornicroft also found a large and significant pay premium for airline pilots, and a smaller but still significant pay premium for airline mechanics.

Thornicroft also noted a worrisome trend of declining productivity in his study. He noted that in 1930, airline pilots worked 85 block hours per month. However by 1985, airline pilots only worked on average 44.3 block hours per month. Block hours are calculated as the time between pushing-back before departure and parking at the gate after arrival. The

combination of high pay premium and low productivity results in high labor costs for the airlines.

In summary, Hirsch & MacPherson (2000) and Thornicroft (1989) examined airline labor pay premium over comparable jobs in other industries. Even though the base pay for other industries they used differ, they came to the conclusion that most airline employees enjoy a pay premium over comparable jobs in other industries. Airline employees, even after deregulation, were able to extract significant labor rent.

### **5.2.2 Effects of Regulation, and Explanation for Pay Premium under Regulation for the Airline Industry**

There are several published papers discussing the effect of government regulation on labor rent or pay premiums. There are also papers discussing why government regulation leads to labor rent. A summary of the most relevant papers is presented below.

After calculating labor pay premium, Hirsch & MacPherson (2000) went on to study the reason behind this labor pay premium. They stated that unions provide an institutional mechanism that facilitates the transfer of rents from shareholders to workers. The results of their study indicate that much of the earnings advantage of airline employees can be associated with unionization. They did discuss that over time, the airline industry pay premium has fallen. However, they also believe that all remaining pay premium is union related. They noted that pattern bargaining often leads to higher salaries, while union bargaining power is constrained by competition and weak financial conditions of carriers.

Thornicroft (1989) went on to look at union labor productivity. He stated that unionization, restrictive work rules, and specialized job categorization tended to inflate the number of employees required. The unionized labor force receives a pay premium over comparable jobs, while at the same time produces low productivity. Levine and Levengood (1983) also noted that unionized labor exploited their favored position and

tend to secure very generous compensation packages from employers. The factors above combine to create an expensive workforce with low productivity.

The above papers have stated that unionization lead to high pay and low productivity. This raises the question of how government regulation could affect unionization, union pay, and union productivity.

Henricks, Feuille, & Szerszen (1980) tested the hypothesis that government regulation increase union power, and found results that support this hypothesis. They wanted to understand how regulation could influence the balance of power in collective bargaining. They found that regulation has two major potential impacts: 1) regulation influences management's choice of the quality of the labor force, and 2) regulation influence the structure of the product and labor markets in the industry. They went on to state that the Railroad Labors Act (RLA) contributed to a large number of bargaining units, resulting in pattern bargaining as well as inter-union rivalries. They suggested that high employee earnings in airlines can be attributed to the industry characteristics of high unionization and concentration, both are results of regulation. They stated that regulation may have increased union power in airlines both indirectly through the impact of entry restrictions on labor and product market characteristics and directly through altering managerial incentives for cost minimization.

In a similar paper, Hendricks (1977) stated that regulation may increase union power by reducing competition. In his follow-on paper, Hendricks (1994) again stated the three reasons why he believed government regulation had an impact on labor earnings. Hendricks claims the reasons are: 1) Regulatory agencies set prices or restrict entry which guarantee rents for the industries' firms; 2) government regulation could alter the allocation of bargaining power; and 3) regulation could influence employment and output.

In summary, previous research has shown that unionization is a major reason behind airline pay premium discussed in Section 5.2.1. Previous research has also shown that

government regulation of the airline industry was a major reason behind the high unionization and high concentration, which lead to high labor earnings. Regulation may have increased union power through control of entry restriction and market characteristics, as well as reducing manager's incentive to control costs.

### **5.2.3 Effect of Deregulation: Predictions and Actual Impacts on Unionization and Labor Rent**

If regulation is indeed the source of labor rent, then deregulation should have lead to a decrease in union power and labor rent. A summary of the most relevant papers studying post-deregulation impacts is presented here.

Hirsch & MacPherson (2000), thorough analogy to the trucking industry, postulated that if substantial rents exist, airlines would have the opportunity to increase profitability and lower prices through reductions in compensation. They cited results from Rose (1987) that showed there was a large wage drop in the wages of unionized labor after deregulation in the trucking industry, while there was little change to the wages of non-unionized labor. Hirsch & MacPherson also discussed the phenomenon of a non-unionized "company within company" that is common in trucking and construction industries after deregulation.

However, Thornicroft (1989) predicted that the impact of deregulation on labor rent would be minimal. He stated that long term airline employees would have little to fear from deregulation, and that deregulation would actually enhance labor's position in view of increases in employment opportunities.

Similarly, Henricks, Feuille, & Szerszen (1980) predicted that deregulation would have little effect on union power, and thus have little effect on labor pay. Their reason is as follows: 1) they do not believe the pre-deregulation industry structure and level of unionization would have changed substantially; 2) after deregulation, airlines would have been able to lower fares and increase passenger volume. They also would have been able

to drop unprofitable routes. This should have led to higher profits for airlines; and 3) deregulation also brought the abolishment of the mutual aid pact. All of the factors stated here should have increased airlines' reluctance to take strikes, and this should help unions retain bargaining power.

Henricks, Feuille, & Szerszen also stated that deregulation would have increased competition, but this increase in competition would be among existing airlines instead of against new entrant carriers. They believed that industry and unionization characteristics that developed over forty years of regulation have created a bargaining environment that should not change substantially with deregulation. They predicted that airline collective bargaining should have continued to reflect the impact of the regulatory environment.

It appears that around the time of deregulation, researchers concluded the impact of deregulation on labor rent and union power would be minimal. This raises the question of what actually happened to labor rent and union power since deregulation.

Johnson (1991) studied the effects on airline employees' earnings. The results of her study did not support the belief that deregulation decreased earnings. Her explanation of why employee earnings have not changed significantly is that deregulation had not significantly weakened the airlines' market power. She noted that collective bargaining is still very fragmented due to a large number of unions, and the unionization level of the industry also stayed steady. The author believed that the reason for the small change in airline employees' earnings post deregulation was due to the low market share of non-unionized new entrants.

Johnson also looked at each labor group to study the impacts of deregulation. Her hypothesis was that pilots had the greatest strike power. Pilots have a special skill, and are not easily replaceable, giving them more bargaining power. Pilots also have a high cost of changing jobs because of the steep seniority structure. Also, ALPA represents almost all pilots in the major carriers, with little competition from other unions. Pilots have the most to lose due to the high cost of changing jobs, plus they have no other union



to turn to for representation, and as a result, the pilots have the strongest strike threat. As for the mechanics, Johnson concluded that they have a much shorter seniority ladder, as well as plenty of job opportunity outside of the airline industry. Therefore, they are the least likely to grant concessions. The author also noted that the inclusion of unskilled baggage handlers tend to erode mechanics' bargaining power, and therefore is understandable that at several airlines mechanics and bag handlers now have separate contracts. (Von Nordenflycht, unpublished) Finally, Johnson suggested that flight attendants have a very weak bargaining position. She noted that flight attendants have lots of representation competition, so they are also less likely to give up concessions. However, since flight attendants are more easily replaced, their strike threat is not as strong as other groups such a pilots. Therefore the flight attendants unions are in a difficult position. On the one hand they are unwilling to give concessions due to representation competition, but on the other hand a strike threat is not very effective because they are more easily replaceable.

Hirsch & MacPherson (2000) stated that after deregulation, one might expect labor unions to maintain long run rents for their members only if there were substantial barriers to entry. They observed that 20 years after deregulation, the airline industry regarding union power and pay premiums have not yet settled into the steady state. They suggested that wage premiums remain, but they appear modest for most airline employees with the notable exception of pilots. Union power eroded over time due to price competition by low-cost carriers. Part of the reason why the airline industry has not reached long run rents for union members is that employees also benefited from the price-driven expansion of the airline industry.

In summary, previous research has shown that regulation and union power are the reasons behind the pay premium in the airline industry. As for the impact of deregulation, most researchers predicted that the changes in union power and pay premium would be minimal. Evidence from the 20 years since deregulation supported the predictions made prior to deregulation. Labor rent has not reached its long run equilibrium because the

market share of low-cost new entrants is still small, and priced based expansion helped unions retain bargaining power.

#### **5.2.4 Discussion of Problems Facing the Industry**

Bejou & Rakowski (1992) used a life cycle analysis approach to examine the deregulated U.S. airline industry. Life cycle analysis is defined as profession of a specific product (or service) from market development to market decline. The four phases relies on the analogy to life – birth, growth, maturity/marriage, and death. The authors compared the initial growth in air travel after deregulation to the birth/growth period, and the mergers and resulting market maturity in the mid to late 1980s as the maturity/marriage stage. This analogy raises a serious question for existing major carriers. The stage following maturity is death. If the stakeholders in the airlines do not work together and change their fundamentals, these existing major carriers will have to face death. Ever since the mergers in mid to late 1980s, several existing major carriers have faced bankruptcy or liquidation. As new entrants enter the market place with low cost and high productivity, the existing majors may become extinct, as predicted by the life cycle analysis, unless all the stakeholders work together to improve their competitiveness.

Ruben (1997) pointed out that in order for a company to be more competitive, it could lead to difficult bargaining. The author used the railroad industry as an example, and cited that as railroad management attempted to become more competitive with other modes of transportation, there was increased pressure on labor to reduce costs and increase productivity. It is possible to draw parallels in the airline industry. As new entrants enter the marketplace, existing majors need to become more competitive by reducing labor cost and increasing labor productivity. The researcher suggested that both labor and management have to realize that there will always be new entrants, and the only way they can survive is to work together and become more competitive.

Another major labor problem facing the industry is the inequality amongst unions. Henricks (1977) stated that it is possible that certain occupational groups in a highly unionized industry may have been able to capture rents at the expense of other workers. The examples Henricks gave were railroad trainman and airline pilots. As other unions sense this unfairness in rent, they may show resentment, and may create an even more difficult labor relations environment. For example, other union groups may want to request similar pay raises to the pilots.

Johnson (1991) also found that pilots captured regulatory rents more than other groups. Under regulation, rent earned by employees was shared evenly among occupation groups. However, Johnson noted that today pilots seem to be extracting a much larger share of the rent. This inequality could cause problems with labor relations amongst unions. Shultz and Meyer in their 1950 study found that the craft with most bargaining power did not ask for excessive wage demands because they would consider their ultimate influence on the firm's total labor costs. Since deregulation, especially in the late 1990s, pilots in some cases asked for large wage demands without considering the ultimate influence on total labor costs. This total disregard by the pilots' union of other unions is a worrisome trend, and was a contributing factor for the state of the airline industry post the peak of the economic cycle of 2000/2001.

It is therefore important to seek a solution where rent is rationally distributed among stake holders. It is not only important to rationally distribute rent amongst the various labor groups; it is also important to rationally distribute rent to other stakeholders such as equity shareholders. If equity holders are not getting their fair share of rent and thus a proper return (profit), they may turn away from the airline industry. This is not a favorable outcome for either management or labor.

Historically, airlines have used layoff as a way to downsize and reduce labor costs. However, this is not the best solution for reducing labor cost. Thornicroft (1989) and common sense show that due to the seniority structure at airlines, average pay per employee actually increases in the event of layoffs. There is a need for both labor and

management to adopt a different compensation mechanism that could keep labor cost inline with revenue. For such a compensation mechanism to be successful, Cappelli (1995) suggested that successful programs must include a cultural change away from adversarial labor – management relations and toward an environment where mutual trust exists between parties. Unfortunately, Cappelli also noted that cultural changes are most likely to occur when unions possesses a strong bargaining position and greater labor market leverage. However, the airlines would really need good labor – management relations when times are tough, but it is also when it is the most difficult for cultural changes to occur.

In conclusion, a quote from Hirsch & MacPherson (2000) stated it the best: “absent greater cooperation, attempts by management or labor to significantly alter compensation levels may produce long run outcomes at individual carriers that are attractive neither to firms’ shareholders nor employees.” Labor and management must work together to alter compensations levels for all labor groups to their long run equilibrium.

### **5.3 Applying the Labor Contract Value Curve Analysis to the US Majors**

In Section 5.3, the formula derived in Chapter 3 will be applied to US Majors. In 5.3.1, the formula for Labor Contract Value Curve (LCVC) will be used to create contract value curves for the US Majors. Based on their wage rate in 2000, the operating point for each airline will be pinpointed. In 5.3.2, historical change to their labor contract value and wage fraction for select airlines will be presented. The result will be used to illustrate how changes in wage rate could impact labor contract value.

#### **5.3.1 Value of Labor Contract in 2000**

Analysis in Chapter 3 concluded that the formula for normalized value of labor contract is the following:

$$\frac{(L - L_{rf})}{\left(\frac{\mu}{r_{rf}}\right)} = \frac{w^*}{\mu} \cdot [N_0 + \rho \cdot N_1 \cdot S_{mkt}]$$

Where:

$\frac{(L - L_{rf})}{\left(\frac{\mu}{r_{rf}}\right)}$  is the normalized value of the labor contract

$\frac{w^*}{\mu}$  is the *Wage Fraction*

$N_0$  is the normal probability distribution

$\rho$  is the correlation between market returns and *adjusted revenue*

$N_1$  is the 1st moment of *adjusted revenue* distribution

$S_{mkt}$  is the Sharpe ratio of the market

Normalized labor contract value is a function of *Wage Fraction*, Sharpe ratio of the market, and correlation between market returns and *adjusted revenue*. *Wage Fraction* is

$\frac{w^*}{\mu}$ ;  $w^*$  is the wage premium per time period (wage premium rate), while  $\mu$  is the

expected value for *adjusted revenue*.  $w^*/\mu$  is essentially the fraction of revenue premium that goes to labor during the time period; the higher the wage rate, the large the *Wage Fraction*. As mentioned earlier, all other cost will be considered sunk cost, and the focus will be on labor salary premium and owner profit premium. *Adjusted revenue* is the sum of these two components.

Another element of interest is the volatility for adjusted revenue, denoted  $\frac{\sigma}{\mu}$ . The

formula for *Wage Fraction* is equal to  $(1 - z^* \frac{\sigma}{\mu})$ .  $z$  covers the range of  $-\infty$  to  $+\infty$ . The

probability of an airline not operating is affected by its revenue volatility. The higher the revenue volatility, the higher the probability that an airline may not operate.

The results presented here are for the year 2000. Later data is available, but due to the events of 9/11, many airlines failed to correctly report their data to the government. Recall that 2000 was at the end of a long economic expansion. Historical data for the values of revenue volatility ( $\sigma/\mu$ ), correlation between *adjusted revenue* and the overall market ( $\rho$ ), and the Sharpe Ratio of the overall market ( $S_{mkt}$ ) for 1985-2000 was used to determine the Labor Contract Value Curve (LCVC) for each airline. For these years, the Sharpe Ratio of the overall market ( $S_{mkt}$ ) was 0.53.

The result of applying the labor contract value analysis to US Majors in 2000 is shown in Table 5-2. In the table, “*Wage Fraction*” is their actual *Wage Fraction* in 2000. Normalized labor contract value, *Optimum Wage Fraction*, and maximum labor contract value are calculated based on each airline’s individual values for  $\sigma/\mu$ ,  $\rho$ , and *Wage Fraction*. The resulting LCVC curves for each airline in 2000 are plotted in Figures 5-7 and 5-8.

	Revenue Volatility ( $\sigma/\mu$ )	Revenue Correlation ( $\rho$ )	Wage Fraction	Normalized Labor Contract Value	Optimum Wage Fraction	Maximum Labor Contract Value	Value of the Labor Contract as a % of Maximum Value
AA	0.23	0.37	0.91	0.43	0.70	0.58	74%
UA	0.26	0.25	1.04	0.32	0.71	0.56	57%
DL	0.24	0.34	0.77	0.56	0.70	0.57	98%
NW	0.36	0.27	0.80	0.47	0.70	0.49	96%
CO	0.71	0.47	0.78	0.30	0.68	0.30	100%
WN	0.45	-0.08	0.40	0.37	0.84	0.57	65%
US	0.38	0.42	1.20	0.13	0.65	0.44	30%
TW	0.51	0.21	1.72	0.07	0.75	0.44	16%
HP	4.42	0.43	2.43	0.38	2.30	0.38	100%
AS	0.56	0.43	1.80	-0.01	0.67	0.35	-3%

**Table 5-2: US Major Airlines in 2000**

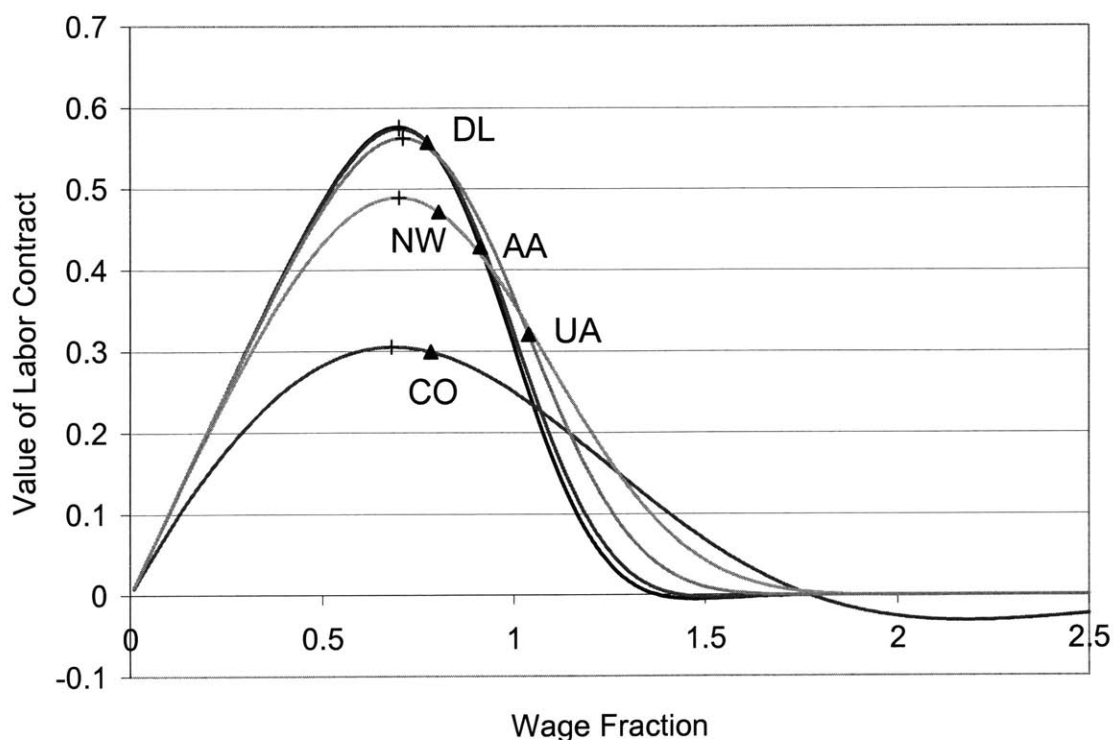


Figure 5-6: Top 5 US Major Airlines in 2000

The LCVCs of the top five US major airlines, as well as the position for these airlines along their LCVC in 2000, is shown in Figure 5-6. Data from 1985-2000 includes two economic expansion periods as well as one recession, so the value of revenue volatility ( $\sigma/\mu$ ) for these airlines do not generate sharp peaks for the Labor Contract Value Curves (LCVC). It is interesting to note that the top four US major carriers had very similar LCVCs, as well as similar *Wage Fractions*. This could be the result of pattern bargaining, as changes in one airline often leads to changes in other airlines. Continental Airlines went through multiple bankruptcies as well as a successful turnaround, so they exhibited the highest value of revenue volatility ( $\sigma/\mu$ ) and lowest position on the curve. In 2000, all five top major airlines had *Wage Fractions* higher than their *Optimum Wage Fractions*, resulting in labor contract values that did not meet their maximum possible values. Delta, Northwest, and Continental's *Wage Fractions* were only slightly larger than their *Optimum Wage Fraction*, and as a result they were able to achieve almost maximum labor contract value. On the other hand, United Airlines had a *Wage Fraction* over 1. All of United's *adjusted revenue* was captured by labor, and its owners made a

lower return than the risk-free rate. The results suggest that labor groups at three of the five top airlines were able to achieve close to maximum labor contract value. Based on the model results, Employees at American and United could actually have contracts of higher value if they reduced their pay toward the airlines' *Optimum Wage Fractions*.

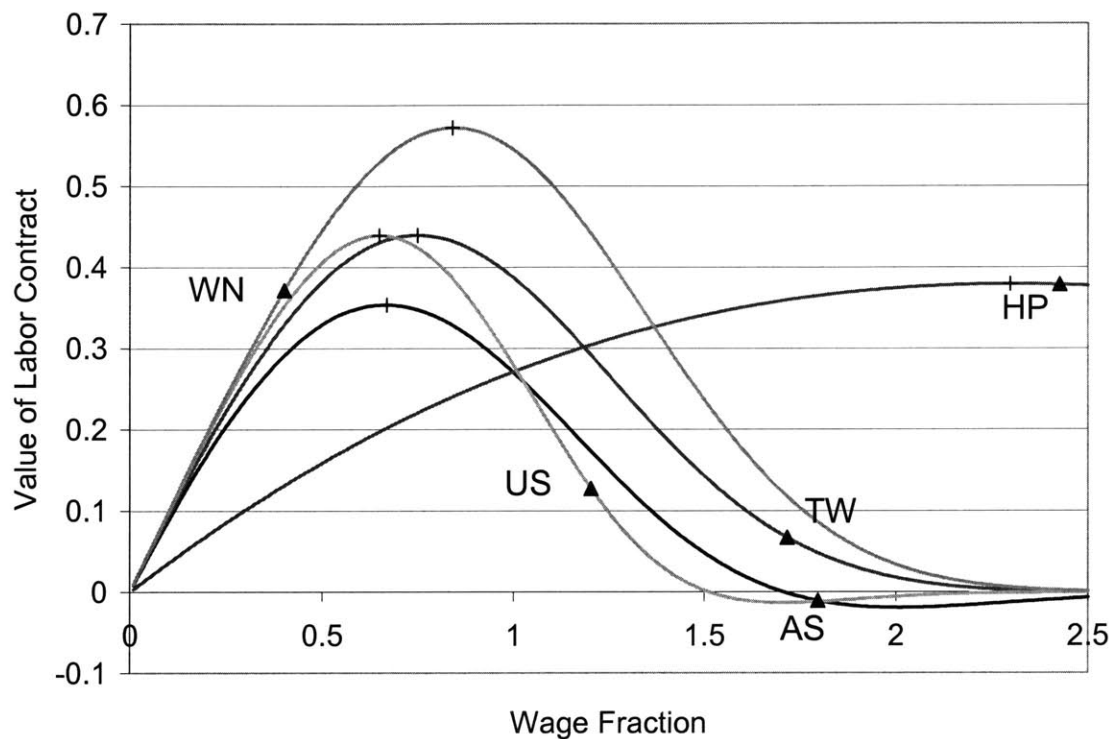


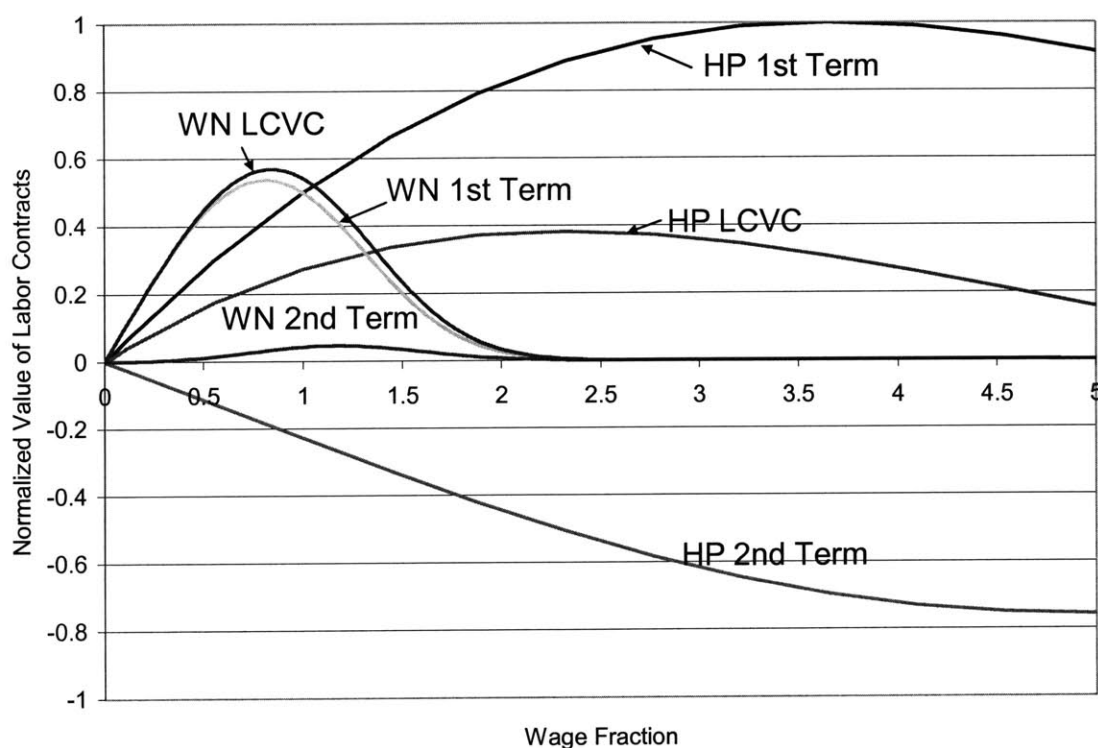
Figure 5-7: Next 5 US Major Airlines in 2000

The LCVCs for the next five smaller US Majors, as well as their positions in 2000, is shown in Figure 5-7. Compared with the top five major airlines, the LCVCs for these five smaller airlines are more varied. For the year 2000, Southwest Airline was the only airline in the majors to have a *Wage Fraction* lower than their *Optimum Wage Fraction*. US Airways, TWA, and Alaska had very high *Wage Fractions* and low values for their labor contracts.

The LCVC for America West was very different from the other majors. Between 1985-2000, American West had a revenue volatility ( $\sigma/\mu$ ) value of over 4, much larger than the



other major airlines. The airline also historically has had low profitability, and its employees also have had a very small pay premium over risk-free wage.



**Figure 5-8: HP LCVC vs. WN LCVC**

Figure 5-8 is a comparison of HP's LCVC with WN's LCVC. Recall from Chapter 3 that the formula for LCVC could be separated into two terms. The first term represents the probability of the company not operating, and the second term represents adjustments to the value of the labor contract based on revenue premium correlation with the overall market. The resulting LCVC is the sum of these two terms. The revenue volatility for America West was much larger than all the other airlines. The effect of higher volatility on the LCVC curves is that the curves are horizontally stretched. The curves from both the first term and the second term are similarly affected. This effect is clearly seen when compared to WN's LCVC.

For America West, even though the airline's *Wage Fraction* is the highest, its labor groups have contracts that are very close to the maximum labor contract value. A *Wage Fraction* of greater than one indicates that the owners were not receiving risk-free

returns. Because the wage premiums were very small for a historically unprofitable airline, an extremely high *Optimum Wage Fraction* resulted.

There were five airlines that had a *Wage Fraction* higher than one in 2000. They were United (UA), USAirways (US), TWA (TW), Alaska (AS), and America West (HP). The implication based on model assumptions is that at a *Wage Fraction* of 1, all revenue premium is captured by labor, while owners only receive risk-free returns. A *Wage Fraction* higher than one suggests that owners are better off investing in risk-free assets instead. By 2002, three of the five airlines, United, USAirways, and TWA, had filed for bankruptcy protection. The owners of America West asked their employees for significant wage reductions and received government loan guarantees to avoid having to file for bankruptcy protection. Except for Alaska Airlines, the airlines with *Wage Fractions* greater than one in 2000 all faced financial trouble by 2002. *Wage Fraction* could potentially be an indicator for bankruptcy.

As for Alaska Airlines (AS), its *Wage Fraction* was between 0.6 to 0.8 for 1996-1999. This range of *Wage Fraction* corresponds to the range of maximum labor contract value. However, from 1999 to 2000, the total number of employees increased by only 2%, but the total salaries and benefits expenses increased by 10%. The airline was unable to turn a profit in 2000, and the value of the labor contract was significantly lowered. Alaska Airlines is an example of how quickly the value of a labor contract could decrease from one year to the next, when labor receives a large pay increase. After 9/11, AS was able to quickly reduce its costs. As a result, they were the only airline out of the five listed above to stay away from financial trouble.

Here is the summary for the LCVCs for US Majors in 2000. The top majors, due to the fact that they compete against each other with nation-wide networks, act as price takers and face similar revenue volatility. Due to pattern bargaining, they also face similar labor costs. As a result, their LCVCs are very similar. In 2000, WN was the only airline operated with a *Wage Fraction* smaller than optimum. CO, DL, NW, and HP operated at a *Wage Fraction* slightly greater than optimum, and were able to achieve a labor contract

close to peak value. The remaining airlines, AA, UA, AS, and US, all operated at a *Wage Fraction* much greater than optimum, resulting in poor labor contract value.

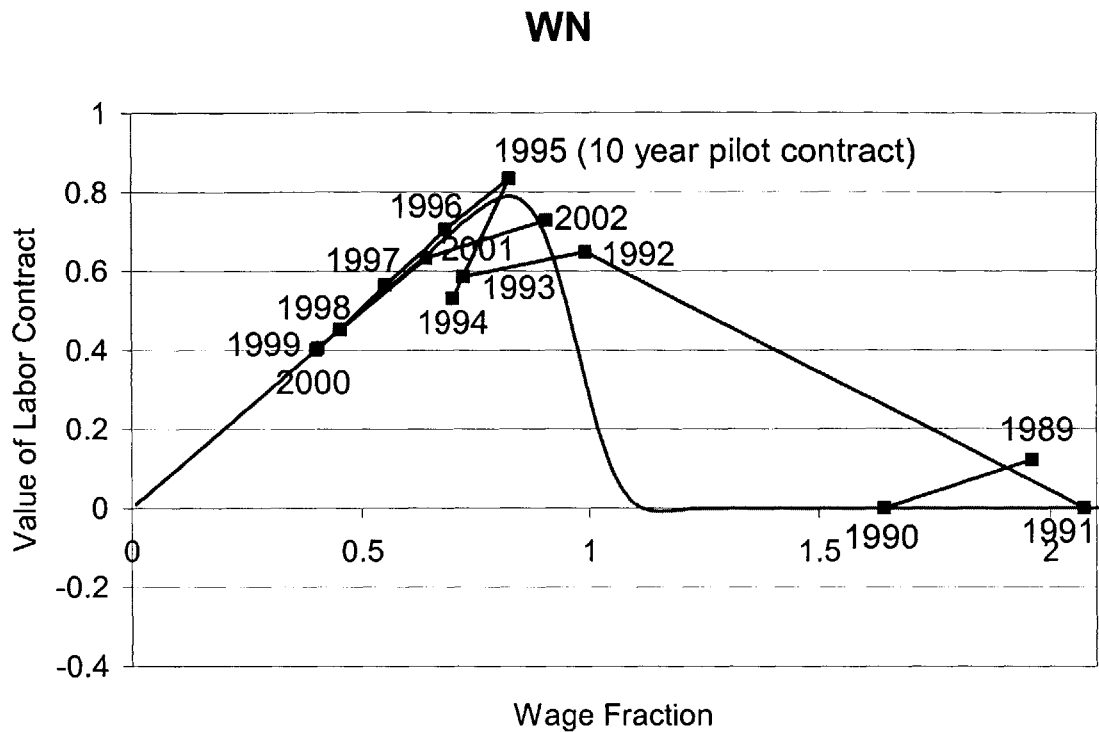
Also in 2000, five of the ten Majors operated at a *Wage Fraction* greater than 1. The significant of *Wage Fraction* greater than 1 is that labor captures all revenue premium, and owners are receiving less than risk-free returns. Four of these five airlines faced financial distress within the next two years.

It is in the interest of all stake holders for an airline to operate at a *Wage Fraction* of less than one. For most airlines in 2000, reducing their wage rate could actually lead to a higher value for their labor contract.

### **5.3.2 Value of Labor Contract over Time**

For this section, the operating position on the Value of Labor Contract – Wage Fraction Chart for select airlines over time is presented. The two airlines selected are United Airlines and Southwest Airlines. These two airlines were selected because they entered employee ownership agreements in the mid-1990s. At the end of the pay-freeze period from the employee ownership plan, one airline achieved continued profitability while the other airline entered bankruptcy. The data is plotted for each year from 1989-2002, and changes in the position are compared to changes in their labor contracts. 2001 and 2002 data are included to illustrate changes after the events of 9/11/2001.

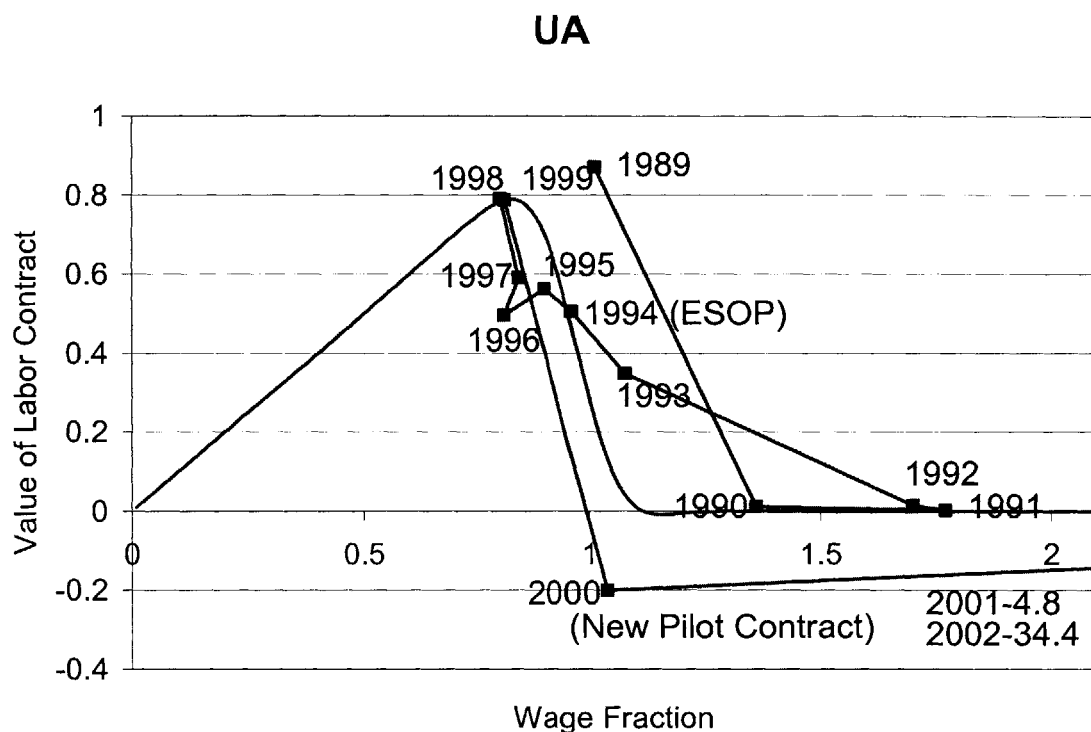
The data used to construct the LCVCs are different in this section. In 5.3.1, the goal was to capture the true long-term fundamental revenue volatility, so historical data from 1985-2000 was used. In this section, the focus is on how the employees might view the airline's underlying revenue volatility when considering a new contract. The contract duration tend to be shorter than the 15-year time frame used in the previous section, so in this section a 5-year rolling data is used.



**Figure 5-9: Value of Labor Contract for WN, 1989-2002**

Southwest Airlines grew significantly during the time frame presented and also became very successful financially. In 2000, WN was the only major airline with a *Wage Fraction* lower than *Optimum Wage Fraction*. Starting in 1992, its *Wage Fraction* consistently remained below 1, while the value of its labor contract stayed high. In 1995, the pilots signed a 10-year labor contract with no pay increases for the first five years. In return, the pilots received stock shares in Southwest Airlines. Even though pilots' pay does not represent the total salaries and benefits of the whole airline, since it is a significant portion, and according to previous research mentioned earlier, other union groups may follow the pilots lead when negotiating new contracts, it is possible to argue that changes in the pilots' contract have a profound effect on the total salary of the company. Also note that the model is simplified to only consider actual pay received by employees, and ignores stocks or stock options. Between 1995 and 1999, partially due to the fact that pilots did not receive any pay increase, Southwest employees' *Wage Fraction* continued to decline, reducing the value of the labor contract based on cash income.

Once pilot wage increased after 2000, the *Wage Fraction* moved to the right, and the value of the labor contract initially increased. Southwest Airlines is still very profitable compared to all other US major airlines, resulting in high value of labor contract. The line represented the location of their LCVC in 2000. Recall that Southwest has a very low revenue volatility ( $\sigma/\mu$ ), and the drop off in labor contract value is significant past *Optimum Wage Fraction*. It is important to note that in 2002, Southwest was already operating at a *Wage Fraction* greater than the optimum. Any further increase in their *Wage Fraction* could lead to a sharp decrease in their labor contract value, as suggested by the LCVC. Southwest' employees need to monitor their *Wage Fraction* carefully to avoid any decline in the value of their labor contract.



**Figure 5-10: Value of Labor Contract for UA, 1989-2002**

A large percentage of United Airlines employees joined their employee ownership program in 1994 in exchange for lower pay. The result was that their *Wage Fraction* decreased below 1, and the value of their labor contract increased from 1994-1999. By 2000, the airline enjoyed several years of profitability, and pilots negotiated a large pay raise. The shape of UA's LCVC in 1999 is depicted here. As illustrated, UA operated at

near the peak labor contract value for 1999. Any increase in their *Wage Fraction* would result in significantly lower value for their labor contract. The pilots failed to realize this point, and negotiated a contract with large pay raises. The result was very poor value for their labor contract. Furthermore, in 2001 and 2002, their *Wage Fraction* increased to 4.8 and 34.4 respectively. The airline could not sustain such a high *Wage Fraction*, and needed to reduce labor cost. The employees did not realize this, and the airline was forced to file for bankruptcy protection in late 2002. Union groups need to be very careful not to negotiate labor contracts with *Wage Fractions* higher than optimum because the resulting contract may have a very poor value.

In summary, from 1989 to 2000, Southwest Airlines had consistently high value for its labor contract. Based on the shape of their LCVC, the increase in *Wage Fraction* in 2001 lead to even higher value for their labor contract. However by 2002, Southwest's *Wage Fraction* increased past optimum. The shape of their LCVC indicates that the drop-off in labor contract value is large if the *Wage Fraction* is higher than the *Optimum Wage Fraction*. Even though Southwest has historically been able to maintained high value for its labor contract, their management and labor groups have to be careful not to exceed their *Optimum Wage Fraction*.

A large portion of United Airlines' employees entered into the employee ownership plan in 1994. Initially, this Employee Share Ownership Plan (ESOP) was successful in reducing *Wage Fraction* and increasing labor contract value. However, in 2000 pilots negotiated for a large pay increase. The result was that their *Wage Fraction* was higher than their *Optimum Wage Fraction*, and the value of the labor contract was poor. The airline was subsequently forced to file for bankruptcy protection.

Labor groups must realize that demanding a large increase in their salaries could cause the *Wage Fraction* to increase past the optimum value. The result may be significantly lowered value for their contract, as evident from the United Airlines' contract in 2000.

## 5.4 Applying the Value of Labor Contract Comparison between Employee Groups to US Majors

In the United States, the Railway Labors Act governs airline labor contracts. This Act specified that unions within a company have to be organized along the line of their crafts. At all US Major carriers, therefore, each employee group, separated by their craft, is represented by its respective unions. The three largest unions in every US Major carriers are the pilots' union, the flight attendants' union, and the mechanics' union. There are other unions such as ground agents' or dispatchers' unions, but their sizes are usually smaller than the three largest unions at an airline. The focus of this chapter is to analyze revenue premium distribution among these three unions at US Major airlines.

In Section 3.4, a formula for comparing labor contract value between different employee groups within the same company was derived. In this section, this formula will be applied to study labor contract value comparison between employee groups for US Majors.

The formula from Section 3.4 is the following:

$$\therefore \frac{\frac{w_{2b} - 1}{w_{1b}}}{\frac{w_{2a} - 1}{w_{1a}}} = \frac{\delta_b}{\delta_a}$$

Where:

$w_1$  = risk free wage rate

$w_2$  = labor wage rate

$\delta$  = frictional loss fraction for labor if decide to seek the risk free alternative

subscripts  $a$  and  $b$  denotes labor groups  $a$  and  $b$ .

This formula suggests that under equilibrium conditions, between two labor groups, the ratio of pay premium is equal to the ratio of the frictional loss fraction. The pay premium is tied to the difficulty in finding the alternative risk-free job.

For each labor group, there are three variables – labor wage rate, risk free wage rate, and the frictional loss fraction for switching to the risk free alternative. The frictional loss fraction is the fraction of the risk-free wage the employee would lose if he/she has to switch to a risk-free job. For the case of the airlines, only the labor wage rate is known. Neither the risk free wage rate, nor the frictional loss fraction, is available. Therefore, in this section two separate approaches will be taken:

- 5) The first approach is to make the assumption that the value of frictional loss fraction is equal between two labor groups, ( $\delta_a = \delta_b$ ). By making this assumption, then one could say that the wage premium percentage of the two groups are equal ( $w_{2b}/w_{1b} = w_{2a}/w_{1a}$ ). Since the actual wage rates for each labor group is known, it is possible to make inferences regarding the relative implied risk free wage rates.
- 6) The second approach is to assume that the value of frictional loss fraction is not equal between all labor groups. If the value of frictional loss fraction is not equal between the two labor groups, but if the appropriate risk free wage can be chosen, then it is possible to calculate the relative implied frictional loss fraction values.

The reason for having these two separate approaches is because there are three variables, two unknowns, but only one equation.

#### **5.4.1 Assume Value of Frictional Loss Fraction is Equal between Two Labor Groups**

In this section, the value of frictional loss fraction is assumed to be equal for all three labor groups. By assuming equal frictional loss fraction, it is possible to calculate the ratio of implied risk-free wage, based on historical wage rate. Note that at the same frictional loss fraction values, because different labor groups have different risk-free wages, the actual cost of switching to a risk-free job is still different. Another way to view the assumption that the value of frictional loss fraction is equal is to assume that the



amount of time it takes, or the percentage of salaries lost, to switch to a risk-free job, is equal among labor groups.

From Section 4.1, equilibrium condition between two labor groups occurs when:

$$\frac{\frac{w_{2b} - 1}{w_{1b}}}{\frac{w_{2a} - 1}{w_{1a}}} = \frac{\delta_b}{\delta_a}$$

Assuming that the value of the frictional loss fraction to switch to the risk-free job for all labor groups are equal, then the equilibrium condition is:

$$\frac{w_{2a} - 1}{w_{1a}} = \frac{w_{2b} - 1}{w_{1b}}$$

Since the focus is on the three largest union groups in US major airlines,

$$\frac{w_{2Pilots}}{w_{1Pilots}} = \frac{w_{2FlightAttendants}}{w_{1FlightAttendants}} = \frac{w_{2Mechanics}}{w_{1Mechanics}}$$

or, the percentage wage premium is the same for all labor groups. In the remainder of this section, average salaries for pilots, flight attendants, and mechanics are presented. Since the equilibrium condition dictates that the percentage wage premium is the same, the ratio between their actual salaries is also the ratio between their implied risk-free salaries.

Pilot Wage Summary Table, all corrected to 2000 \$							
Year	1997	1998	1999	2000	2001	2002	Average
AA	117834	117439	105426	101566	90285	85307	102976
AS	99708	99891	96136	98346	103938	104545	100427
CO	103310	126418	145110	140477	133591	98848	124626
DL	112871	101114	116962	118974	143328	127225	120079
HP	75645	71409	70067	70880	70136	63210	70225
NW	109481	119167	99667	100811	99512	100043	104780
TW	70714	72791	73807	72008			72330
UA	133072	115014	95417	110250	102363	117870	112331
US	107880	108425	97631	86085	112236	99403	101943
WN	87381	79317	76367	71951	73052	78154	77704

**Table 5-3: Pilot Wage Summary Table**

The average pilot wages for the US Major airlines from 1997 to 2002 is listed in Table 5-3. The figures listed in these three tables do not include benefits. The values are

inflation-corrected to 2000 dollars. The average pilot at a US Major airline earns between \$70,225 and \$124,626 annually, with an average of \$98,742, and a standard deviation of \$19,238. There are many such factors that could influence pilot wage rate as differences in route network, type of aircraft flown, and the average seniority level/wage of the pilots. Prior to 2001, changes in the average wages could be due to an increase in contractual wage. Changes could also be due to a significant increase in the number of new-hire employees, as was the case for Southwest Airlines (WN). By 2002, the average pilot wage at some airlines declined because many airlines faced bankruptcy and were forced to reduce wages.

Mechanics Wage Summary Table, all corrected to 2000 \$							
Year	1997	1998	1999	2000	2001	2002	Average
AA	59531	52771	47468	49078	48517	54728	52015
AS	44167	40616	36434	38320	44681	45132	41559
CO*	90104	90616	93460	90004	84740	74940	87311
DL	45298	42435	34879	62432	57845	55282	49695
HP	43883	43825	46652	49022	46166	42093	45274
NW	58884	54567	48294	52881	70961	69008	59099
TW	40724	42451	41048	39680			40976
UA	54801	51513	48501	49525	50281	42532	49526
US	53992	55080	59936	57816	64422	49873	56853
WN	65000	65872	65570	64839	62802	65770	64975

**Table 5-4: Mechanics Wage Summary Table**

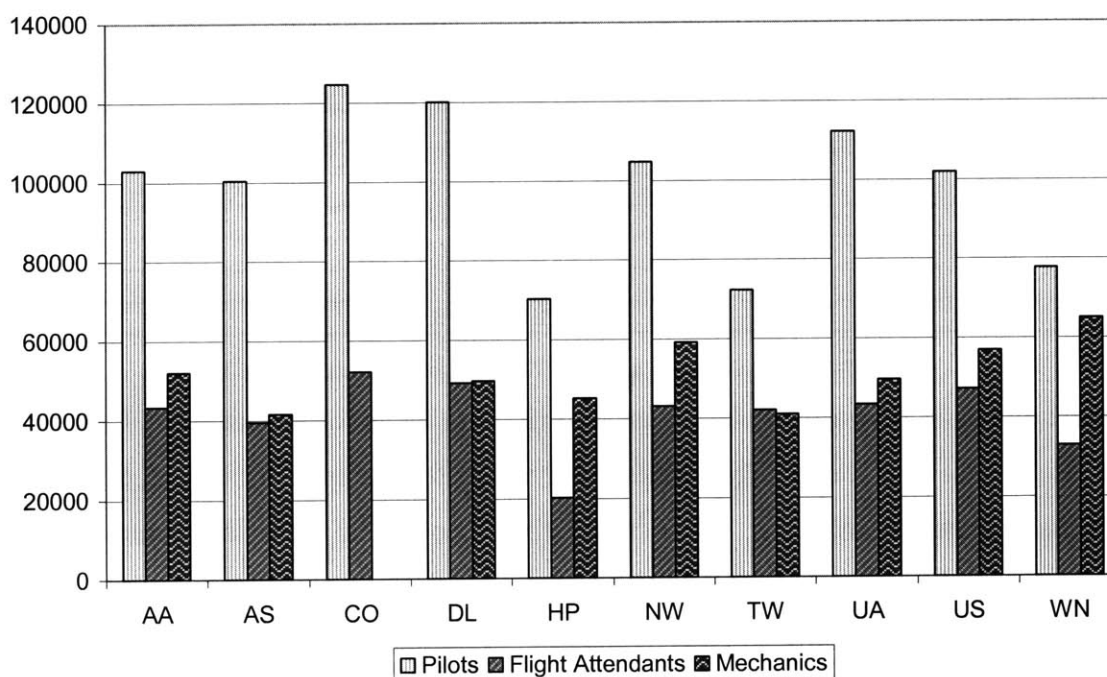
Mechanics at US Major airlines earn between \$40,976 and \$87,311 annually. Note that the data for Continental Airlines (CO) contain errors. The problem was that Continental changed the classification of some employees from “mechanics” to “other employees”, while still reporting their salaries under maintenance personnel. Continental data is listed here for completeness, but will not be used for the analysis. The numerical average of the nine airlines is \$51,108, with a standard deviation of \$8,081. Again, this wage is calculated without benefits and corrected to 2000 dollars.

Flight Attendant Wage Summary Table, all corrected to 2000 \$							
Year	1997	1998	1999	2000	2001	2002	Average
AA	45538	46845	39978	39851	41058	46863	43356
AS	43790	39839	38399	40154	37350	37519	39509
CO	47534	47470	55089	58414	54869	49215	52099
DL	49472	48445	48926	48699	50029	49395	49161
HP	19776	18966	21611	27829	18859	14114	20192
NW	43504	42312	41902	42253	43829	44807	43101
TW	34954	40058	48529	44390			41983
UA	44621	45812	41427	41897	37741	48782	43380
US	46818	45178	46414	42491	59879	42274	47176
WN	34431	34380	30511	31805	32568	33774	32912

**Table 5-5: Flight Attendant Wage Summary Table**

Flight attendants at US Major airlines earn \$20,192 to \$52,099 annually without benefits. The numerical average of the ten airlines is \$41,287, with a standard deviation of \$9,094.

### Pilots, Flight Attendants, and Mechanics Wage Comparison



**Figure 5-11: Pilots, Flight Attendants, and Mechanics Wage Comparison**

The average annual salaries of pilots, flight attendants, and mechanics is compared in Figure 5-11. For all US Majors, pilots have the highest average annual salaries. These data will be used to make a comparison of implied risk-free wage.

Recall that by assuming the frictional loss fraction is the same, the relationship between pilots' wage and mechanics' wage is the following:  $\frac{w_{2Pilots}}{w_{1Pilots}} = \frac{w_{2Mechanics}}{w_{1Mechanics}}$

Since  $w_{2Pilots}$  and  $w_{2Mechanics}$  are known, by rearranging the formula,

$$\frac{w_{2Mechanics}}{w_{2Pilots}} = \frac{w_{1Mechanics}}{w_{1Pilots}}$$

A similar formula can be constructed for *Flight Attendants* vs. *Pilots*. The ratio of actual wage rate is equal to the ratio of the implied risk-free wage rate. The following two tables calculated mechanics' wage and flight attendants' wage as a percentage of pilots' wage. According to this formula above, the percentages presented here also signifies the implied risk-free wage for mechanics' and for flight attendants' as a percentage of that for pilots'.

Mechanics' Wage as a Percentage of Pilots' Wage							
Year	1997	1998	1999	2000	2001	2002	Average
AA	51%	45%	45%	48%	54%	64%	51%
AS	44%	41%	38%	39%	43%	43%	41%
CO*	87%	72%	64%	64%	63%	76%	70%
DL	40%	42%	30%	52%	40%	43%	41%
HP	58%	61%	67%	69%	66%	67%	64%
NW	54%	46%	48%	52%	71%	69%	56%
TW	58%	58%	56%	55%			57%
UA	41%	45%	51%	45%	49%	36%	44%
US	50%	51%	61%	67%	57%	50%	56%
WN	74%	83%	86%	90%	86%	84%	84%

**Table 5-6: Mechanics' Wage as a Percentage of Pilots' Wage Table**

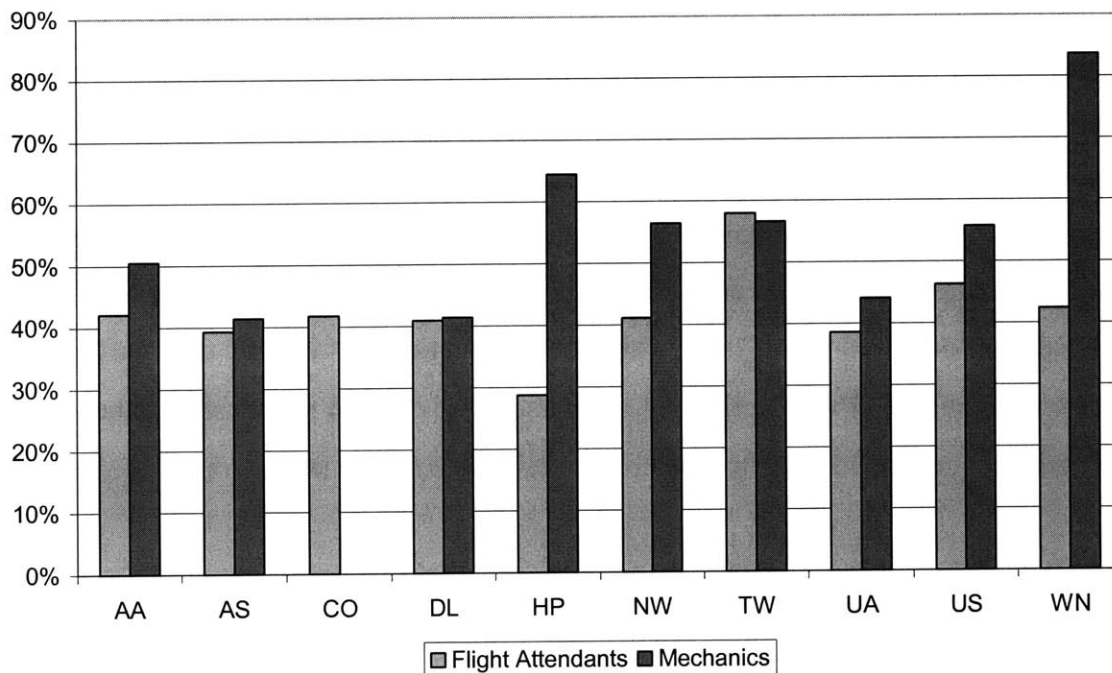
Based on historical wage levels, the implied risk-free wage for mechanics is 41% to 84% of pilots' risk-free wage. The numerical average for the nine airlines is 55% with a standard deviation of 13%. Note again that Continental data is erroneous, but is presented here for completeness.

Flight Attendants' Wage as a Percentage of Pilots' Wage							
Year	1997	1998	1999	2000	2001	2002	Average
AA	39%	40%	38%	39%	45%	55%	42%
AS	44%	40%	40%	41%	36%	36%	39%
CO	46%	38%	38%	42%	41%	50%	42%
DL	44%	48%	42%	41%	35%	39%	41%
HP	26%	27%	31%	39%	27%	22%	29%
NW	40%	36%	42%	42%	44%	45%	41%
TW	49%	55%	66%	62%			58%
UA	34%	40%	43%	38%	37%	41%	39%
US	43%	42%	48%	49%	53%	43%	46%
WN	39%	43%	40%	44%	45%	43%	42%

**Table 5-7: Flight Attendants' Wage as a Percentage of Pilots' Wage Table**

Based on historical wage levels, the implied risk-free wage for flight attendants is 29% to 58% of pilots' risk-free wage. The numerical average for the ten airlines is 42% with a standard deviation of 7%.

#### Risk-Free Wage as a Percentage of Pilots' Risk-Free Wage



**Figure 5-12: Risk-Free Wage as a Percentage of Pilots' Risk-Free Wage**

The results of Tables 5-6 and 5-7 are combined and shown in Figure 5-12. Interestingly, the wages of flight attendants and therefore, the implied risk-free wage, as a percentage of pilots' wage, are consistent across all US Majors. Only the airlines HP and TW had values different from the other airlines. On the other hand, the variance in the wages of

mechanics as a percentage of pilots' wage is much greater across different airlines. With the exception of TW, the remaining nine US major airlines had higher wage for mechanics than for flight attendants. The average implied risk free rate for mechanics is 55% of pilots' average risk free rate, while the average implied risk free rate for flight attendants is 42% of pilots' average risk free rate. This difference implies that the risk-free wage for mechanics is higher than that for flight attendants. Of course, the implied risk-free wage for pilots is the highest among the three labor groups.

#### 5.4.2 Implied Value of Frictional-Loss Fraction for Labor Groups

An alternative analysis is to assume that frictional-loss fraction values are not equal. In order to make a comparison between contracts of different labor groups, the risk free wage values have to be provided. In this section, the risk-free wage used will be based on previous research.

The frictional loss is the fraction of risk-free wage required for an employee to move to the risk-free job. It is expressed as a fractional value. The total cost for an individual employee to switch to the risk-free job is the frictional loss value multiplied by their risk-free wage. Frictional-loss could be of many forms, including cost of a new job search and lost wages. The model does not distinguish between different forms of frictional-loss; all frictional-loss would be considered in one variable – “ $\delta$ ,” and the total frictional-loss cost would be  $\delta \cdot w_l$ . Section 5.4.1 assumed that  $\delta$  is the same for all labor groups; this section attempts to calculate the implied relative  $\delta$  for the labor groups.

Recall from Section 4.1, equilibrium condition between two labor groups occurs when:

$$\frac{\frac{w_{2b}}{w_{1b}} - 1}{\frac{w_{2a}}{w_{1a}} - 1} = \frac{\delta_b}{\delta_a}$$

The goal in this section is to calculate  $\frac{\delta_b}{\delta_a}$ . Frictional loss for pilots is chosen as the base case, and set to 1. By selecting the risk-free wage for the three labor groups based on

previous research, it is possible to calculate the value of frictional loss fraction for other labor groups as a multiple of pilots' frictional loss fraction.

In Section 4.2, previous study on the airline labor pay premium was discussed. Hirsch & MacPherson (2000) found that in 1994-1997, the pilots' pay premium at US major airlines was 36.4% over military pilots, the mechanics' pay premium was 16.9% over full time mechanics outside the airline industry, and the flight attendants' pay premium was 13.9% over general sales, administration and service occupations. A similar study by Thornicroft (1989) found that in 1980, the airline pilots' pay premium over Navy pilots was 59%, the airline mechanics' pay premium over auto mechanics was 28%, and the flight attendants' pay premium over teachers and nurses was 0%.

Both Hirsch & MacPherson, and Thornicroft, used military pilots as the risk-free alternative for airline pilots. Even though it is not possible for an airline pilot to return to the military, the salaries of military pilots is the best choice for risk-free pilot salary. It is reasonable to consider that military pilots might consider the salaries and risks of flying for an airline when they have to decide whether to retire from the military. For the remainder of this Chapter, the risk-free wage for pilots was calculated using government published base pay wage data for US Air Force pilots. A US Air Force pilot's pay package may include cost-of-living adjustments, depending on where the pilot is stationed, but this element is not included in the calculation of risk-free wage. Also, Navy pilots receive similar but slightly higher pay levels. The value used for the calculation of risk-free wage is the average of the O3 and O4 (Officer) wage scales with 15 years of experience. This data provides a reasonable value for salaries of military pilots who may be deciding to retire from the military and to join an airline.

For mechanics' risk-free wage, average salaries for auto mechanics across the nation were used. The use of auto mechanic salaries is consistent with the choice made by Hirsch & MacPherson and Thornicroft.

For flight attendants' risk-free wage, national average salaries for secretaries were used. The reason for this selection was data availability. This selection is in accordance with Hirsch & MacPherson, who chose a broad description of general sales, administration and service occupations. On the other hand, Thornicroft selected salaries for teachers or nurses as the risk-free alternative for flight attendants. Teachers and nurses have higher salaries than secretaries, and the difference in the selection of the risk-free alternative accounts for the discrepancy between the conclusions by Hirsch & MacPherson and by Thornicroft. The criteria for selecting the risk-free alternative are jobs with similar educational backgrounds and/or job characteristics. One could argue that being a teacher requires a Masters' degree and being a nurse requires similar advanced training, but being a flight attendant may not require a college degree. Therefore, secretaries were selected as the risk-free alternative for flight attendants instead of teachers and nurses.

In the following section, for each of the three labor groups, the risk-free wage, actual salaries without benefits, and the percentage wage premium received by airline employees, are listed.

Pilots' Wage Premium Summary Table, all corrected to 2000 \$								
Airline	Year	1997	1998	1999	2000	2001	2002	Average
	Risk-Free Wage	52781	52000	51595	51604	53558	55437	52829
AA	Pilot Salaries	117834	117439	105426	101566	90285	85307	102976
	% Wage Premium	123%	126%	104%	97%	69%	54%	95%
AS	Pilot Salaries	99708	99891	96136	98346	103938	104545	100427
	% Wage Premium	89%	92%	86%	91%	94%	89%	90%
CO	Pilot Salaries	103310	126418	145110	140477	133591	98848	124626
	% Wage Premium	96%	143%	181%	172%	149%	78%	137%
DL	Pilot Salaries	112871	101114	116962	118974	143328	127225	120079
	% Wage Premium	114%	94%	127%	131%	168%	129%	127%
HP	Pilot Salaries	75645	71409	70067	70880	70136	63210	70225
	% Wage Premium	43%	37%	36%	37%	31%	14%	33%
NW	Pilot Salaries	109481	119167	99667	100811	99512	100043	104780
	% Wage Premium	107%	129%	93%	95%	86%	80%	99%
TW	Pilot Salaries	70714	72791	73807	72008			72330
	% Wage Premium	34%	40%	43%	40%			39%
UA	Pilot Salaries	133072	115014	95417	110250	102363	117870	112331
	% Wage Premium	152%	121%	85%	114%	91%	113%	113%
US	Pilot Salaries	107880	108425	97631	86085	112236	99403	101943
	% Wage Premium	104%	109%	89%	67%	110%	79%	93%
WN	Pilot Salaries	87381	79317	76367	71951	73052	78154	77704
	% Wage Premium	66%	53%	48%	39%	36%	41%	47%

**Table 5-8: Pilots' Wage Premium Summary Table**



From 1997 to 2002, the wage for Air Force pilots averaged \$52,829 a year. Airline pilots received a wage premium over risk-free wage of 33% to 137%. In comparison, Hirsch & MacPherson found pilots' wage premium to be 36.4%, and Thornicroft found pilots' wage premium to be 59%. Wage premiums at some financially weaker airlines, namely America West Airlines (HP) and TWA (TW), were only 33% and 39% respectively, while wage premiums at other financially weaker airlines, namely United Airlines (UA) and USAirways (US), were 113% and 93%, respectively. In all cases, airline pilots received pay levels significantly higher than the risk-free wage.

Mechanics' Wage Premium Summary Table, all corrected to 2000 \$								
	Year	1997	1998	1999	2000	2001	2002	Average
	Risk-Free Wage	39463	39254	33258	33800	33722	34422	35653
AA	Mechanics Salaries	59531	52771	47468	49078	48517	54728	52015
	% Wage Premium	51%	34%	43%	45%	44%	59%	46%
AS	Mechanics Salaries	44167	40616	36434	38320	44681	45132	41559
	% Wage Premium	12%	3%	10%	13%	33%	31%	17%
CO*	Mechanics Salaries	90104	90616	93460	90004	84740	74940	87311
	% Wage Premium	128%	131%	181%	166%	151%	118%	146%
DL	Mechanics Salaries	45298	42435	34879	62432	57845	55282	49695
	% Wage Premium	15%	8%	5%	85%	72%	61%	41%
HP	Mechanics Salaries	43883	43825	46652	49022	46166	42093	45274
	% Wage Premium	11%	12%	40%	45%	37%	22%	28%
NW	Mechanics Salaries	58884	54567	48294	52881	70961	69008	59099
	% Wage Premium	49%	39%	45%	56%	110%	100%	67%
TW	Mechanics Salaries	40724	42451	41048	39680			40976
	% Wage Premium	3%	8%	23%	17%			13%
UA	Mechanics Salaries	54801	51513	48501	49525	50281	42532	49526
	% Wage Premium	39%	31%	46%	47%	49%	24%	39%
US	Mechanics Salaries	53992	55080	59936	57816	64422	49873	56853
	% Wage Premium	37%	40%	80%	71%	91%	45%	61%
WN	Mechanics Salaries	65000	65872	65570	64839	62802	65770	64975
	% Wage Premium	65%	68%	97%	92%	86%	91%	83%

**Table 5-9: Mechanics' Wage Premium Summary Table**

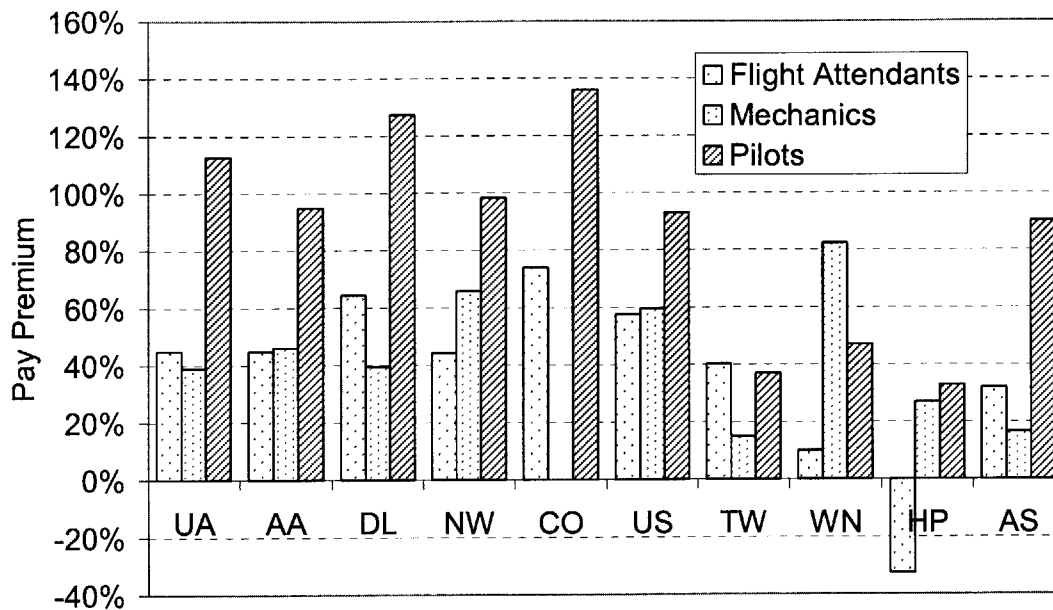
From 1997 to 2002, the wage for auto mechanics averaged \$35,653 a year. Airline mechanics received a wage premium over risk-free wage of 13% to 83%. Continental Airlines' mechanics had a wage premium of 146% on average, but this was due to irregularities in reporting data. In comparison, Hirsch & MacPherson found mechanics' wage premium to be 16.9%, and Thornicroft found mechanics' wage premium to be 28%. Again, similar to pilots' wages, airline mechanics received pay levels higher than the risk-free wage.

Flight Attendants' Wage Premium Summary Table, all corrected to 2000 \$								
Airline	Year	1997	1998	1999	2000	2001	2002	Average
	Risk-Free Wage	30464	30470	29532	29765	29875	29439	29924
AA	FA Salaries	45538	46845	39978	39851	41058	46863	43356
	% Wage Premium	49%	54%	35%	34%	37%	59%	45%
AS	FA Salaries	43790	39839	38399	40154	37350	37519	39509
	% Wage Premium	44%	31%	30%	35%	25%	27%	32%
CO	FA Salaries	47534	47470	55089	58414	54869	49215	52099
	% Wage Premium	56%	56%	87%	96%	84%	67%	74%
DL	FA Salaries	49472	48445	48926	48699	50029	49395	49161
	% Wage Premium	62%	59%	66%	64%	67%	68%	64%
HP	FA Salaries	19776	18966	21611	27829	18859	14114	20192
	% Wage Premium	-35%	-38%	-27%	-7%	-37%	-52%	-33%
NW	FA Salaries	43504	42312	41902	42253	43829	44807	43101
	% Wage Premium	43%	39%	42%	42%	47%	52%	44%
TW	FA Salaries	34954	40058	48529	44390			41983
	% Wage Premium	15%	31%	64%	49%			40%
UA	FA Salaries	44621	45812	41427	41897	37741	48782	43380
	% Wage Premium	46%	50%	40%	41%	26%	66%	45%
US	FA Salaries	46818	45178	46414	42491	59879	42274	47176
	% Wage Premium	54%	48%	57%	43%	100%	44%	58%
WN	FA Salaries	34431	34380	30511	31805	32568	33774	32912
	% Wage Premium	13%	13%	3%	7%	9%	15%	10%

**Table 5-10: Flight Attendants' Wage Premium Summary Table**

From 1997 to 2002, the wage for secretaries averaged \$29,924 a year. Flight attendants received a wage premium over risk-free wage of -33% to 74%. In comparison, Hirsch & MacPherson found flight attendants' wage premium to be 13.9%, and Thornicroft found flight attendants' wage premium to be 0%. Again, the discrepancy was due to the selection of risk-free alternative job.

### Pay Premium Comparison Average of 1997-2002



**Figure 5-13: Pay Premium Comparison for US major airlines**

The data from the three tables are combined and illustrated in Figure 5-13. With few exceptions, pilots had the highest pay premium. For most airlines, flight attendants and mechanics had similar pay premiums over their risk-free jobs, but their pay premiums are much lower than the pilots' pay premium. With the pay premium level established for the three labor groups, it is possible to calculate the inferred ratio of frictional loss for switching to the risk-free job.

Again the formula is:  $\therefore \frac{\frac{w_{2b}}{w_{1b}} - 1}{\frac{w_{2a}}{w_{1a}} - 1} = \frac{\delta_b}{\delta_a}$

Where:

$w_{2a}$  and  $w_{2b}$  are airline employee salaries for labor groups a and b respectively

$w_{la}$  and  $w_{lb}$  are risk-free salaries for labor groups a and b respectively.

$\frac{\delta_b}{\delta_a}$  is the ratio of frictional loss fraction between labor groups a and b.

Let labor group  $a$  be the pilots. The value of  $\frac{\delta_b}{\delta_a}$  is then the ratio of frictional loss fraction between labor group  $b$  and the pilots.

Airline	1997	1998	1999	2000	2001	2002	Average
AA	0.41	0.27	0.41	0.47	0.64	1.09	0.48
AS	0.13	0.04	0.11	0.15	0.35	0.35	0.18
CO*	1.34	0.91	1.00	0.97	1.01	1.50	1.07
DL	0.13	0.09	0.04	0.65	0.43	0.47	0.31
HP	0.26	0.31	1.12	1.21	1.19	1.59	0.82
NW	0.46	0.30	0.49	0.59	1.29	1.25	0.67
TW	0.09	0.20	0.54	0.44			0.40
UA	0.26	0.26	0.54	0.41	0.54	0.21	0.35
US	0.35	0.37	0.90	1.06	0.83	0.57	0.64
WN	0.99	1.29	2.02	2.33	2.37	2.22	1.75

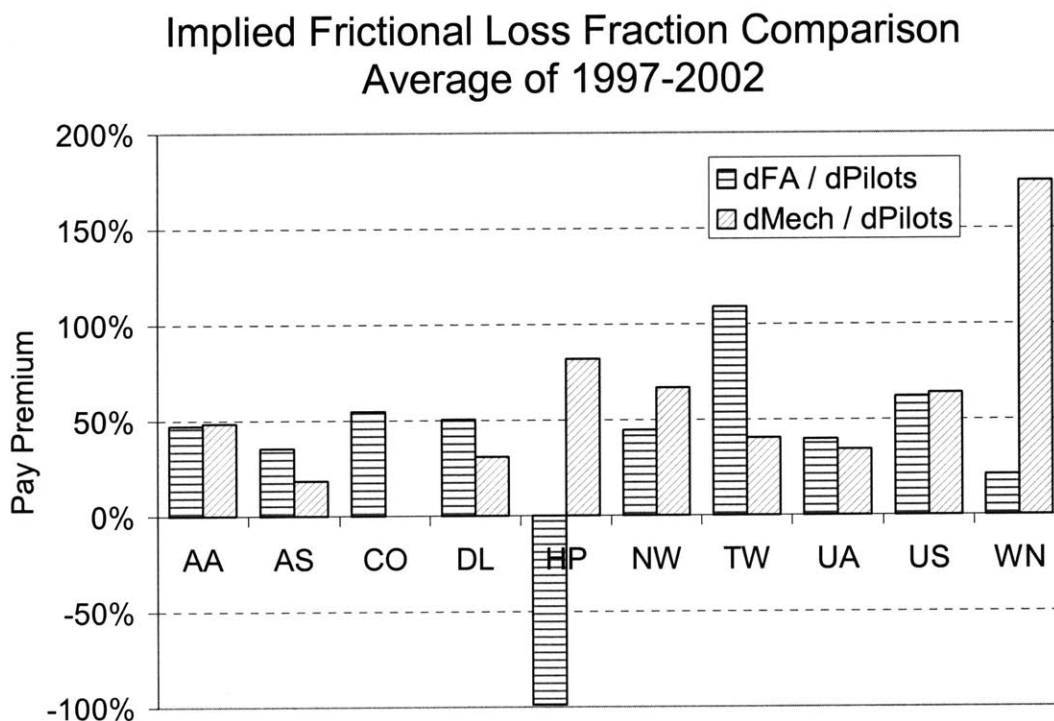
**Table 5-11:**  $\frac{\delta_{Mechanics}}{\delta_{Pilots}}$  Summary Table

The implied frictional loss fraction for mechanics over the implied frictional loss fraction for pilots is shown in Table 5-11. The average fraction value for the US major airlines, between 1997 and 2002, was 0.62 with a standard deviation of 0.47. Data for Continental Airlines is again presented here for completeness, but is not used for average calculations. One interpretation of this result is that mechanics have a frictional loss fraction value that is 62% of the pilots' frictional loss fraction value from switching to a risk-free job. Note that since the pilots' risk-free wage is much higher than mechanics' risk-free wage, the actual total frictional loss cost for pilots is even higher.

Airline	1997	1998	1999	2000	2001	2002	Average
AA	0.40	0.43	0.34	0.35	0.55	1.10	0.47
AS	0.49	0.33	0.35	0.39	0.27	0.31	0.36
CO	0.59	0.39	0.48	0.56	0.56	0.86	0.55
DL	0.55	0.62	0.52	0.49	0.40	0.52	0.51
HP	-0.81	-1.01	-0.75	-0.17	-1.19	-3.71	-0.99
NW	0.40	0.30	0.45	0.44	0.54	0.65	0.45
TW	0.43	0.79	1.49	1.24			1.09
UA	0.31	0.42	0.47	0.36	0.29	0.58	0.40
US	0.51	0.44	0.64	0.64	0.92	0.55	0.62
WN	0.20	0.24	0.07	0.17	0.25	0.36	0.21

**Table 5-12:**  $\frac{\delta_{FlightAttendants}}{\delta_{Pilots}}$  Summary Table

The implied frictional loss fraction value for flight attendants over the implied frictional loss fraction value for pilots is shown in Table 5-12. The average fraction value for the US major airlines, between 1997 and 2002, was 0.37, with a standard deviation of 0.53. One interpretation of this result is that flight attendants have a frictional-loss fraction value that is 37% of the pilots' frictional-loss fraction value from switching to a risk-free job. America West' (HP) flight attendants received an average salary lower than their average risk-free wage rate; therefore, their  $\delta$  is negative.



**Figure 5-14: Implied Frictional Loss Fraction Comparison for US major airlines**

The data presented in Tables 5-11 and 5-12 are illustrated in Figure 5-14. With the exception of the flight attendants at TW and mechanics at WN, pilots had the highest implied fractional loss fraction. With the fact that pilots have by far the highest risk-free wage rate, the relative frictional-loss fraction values for the labor groups suggest that switching to a risk-free job is most costly for pilots.

### **5.4.3 Summary of Comparison of Compensation between Employee Groups**

In Section 5.4, the author studied the distribution of wage premiums among employee groups. The focus was on the three largest employee union groups – pilots, mechanics, and flight attendants. The Sharpe Ratio is selected as the tool for making the comparison. The Sharpe Ratio is the expected return premium divided by the standard deviation of the return premium. Originally, the Sharpe Ratio was developed as a *reward-to-variability ratio* of mutual fund performance. The ratio can also be applied to compare the value of labor contracts among labor groups. The employment equilibrium condition requires that the Sharpe Ratio for the contract of each labor group shall be equal.

In Section 5.4.1, the implied risk-free wage for labor groups was studied, assuming the value of frictional loss fraction is equal for all three labor groups. Historical wage values suggest that the risk-free wage for mechanics is 56% of the risk-free wage for pilots, and the risk-free wage for flight attendants is 42% of the risk-free wage for pilots.

In Section 5.4.2, the implied value of frictional loss fraction for labor groups was studied. In contrast to Section 5.4.1, reasonable risk-free wages were used for each labor group to calculate the ratio of the implied frictional loss. Historical wage values suggest that mechanics faced a frictional loss fraction that is 0.62 of the frictional loss fraction faced by pilots. Also, flight attendants faced a frictional loss fraction that is 0.37 of the frictional loss fraction faced by the pilots.

In Section 5.4.1, it was assumed that frictional loss fraction of switching to a risk-free job is equal for the three employee groups. The results presented in this section suggested that pilots had the highest risk-free wage, followed by mechanics, while flight attendants had the lowest risk-free wage. In Section 5.4.2, reasonable historical risk-free wages was used to suggest that pilots had the highest frictional loss fraction value, followed by mechanics, while flight attendants had the lowest frictional loss fraction value. Both sets of results suggest that pilots had the highest wage premium and risk-free wage, but they also have the highest loss if they have to find a risk-free job. Flight attendants had the lowest wage premium and risk-free wage, but they also have the lowest loss if they have to find a risk-free job.

## **5.5 Post 9/11 Results**

The terrorist attacks in the United States on September 11, 2001, had a large shock on the demand of the US air transportation system. The national airspace was shut down for several days, and airlines faced significantly reduced demand once airspace was reopened. Most airlines were forced to layoff a significant portion of their work force. In Section 5.3, the analysis contains data only up to 2000. In this section though, the analysis focuses on the wage fractions and labor contract value after September 11, 2001.

Since 2001, the US economy entered a recession, and airline profitability suffered. Several airlines signed expensive labor contracts during more profitable times prior to 2001, and following that year these airlines have been facing high labor costs. Several major airlines have filed or about to file for bankruptcy. Between 9/11/2001 and the fall of 2004, USAirways filed for bankruptcy protection twice. As the profitability of each airline decreases, and the risk of bankruptcy increases, the market value of labor contracts significantly becomes lower than the face value of labor contracts. Most airlines had to ask for labor concessions in order to survive. As a result, there is a great disparity between the expected labor pay and the value signed in the contracts. In this section, the wage fraction and labor contract value of the major airlines are presented.

### **5.5.1 Wage Fraction and Labor Contract Values in 2003**

For this section, a new set of LCVCs has been constructed for the US Majors using 2003 data. Expectations in revenue and revenue volatility are calculated again using historical data. The analysis in this section differs from that in Section 5.3. Instead of limiting the historical data from 1987 to 2002, historical data from 2001, 2002, and 2003 are now taken into consideration. Due to the recession in the early 2000's, both revenue volatility and correlation with the overall market for most airlines increased slightly. In Table 5-13, a summary for US Majors in 2003 is presented. The resulting LCVC's are presented in Figures 5-15 and 5-16.



	Revenue Volatility ( $\sigma/\mu$ )	Revenue Correlation ( $\rho$ )	Wage Fraction	Normalized Labor Contract Value	Optimum Wage Fraction	Maximum Labor Contract Value	Value of the Labor Contract as a % of Maximum Value	% Labor Cost Reduction Required for Max Contract Value
AA	0.50	0.49	2.29	0.00	0.72	0.43	0%	27%
UA	0.55	0.39	1.54	0.14	0.76	0.43	33%	19%
DL	0.34	0.43	2.19	0.00	0.71	0.51	0%	35%
NW	0.40	0.41	1.33	0.16	0.72	0.48	33%	23%
CO	0.68	0.45	1.24	0.30	0.80	0.39	77%	13%
WN	0.43	-0.01	0.79	0.55	0.81	0.55	100%	0.4% Increase
US	0.47	0.45	1.93	0.01	0.72	0.44	2%	27%
AS	0.59	0.48	1.34	0.22	0.75	0.40	55%	18%

Table 5-13: US Major airlines in 2003

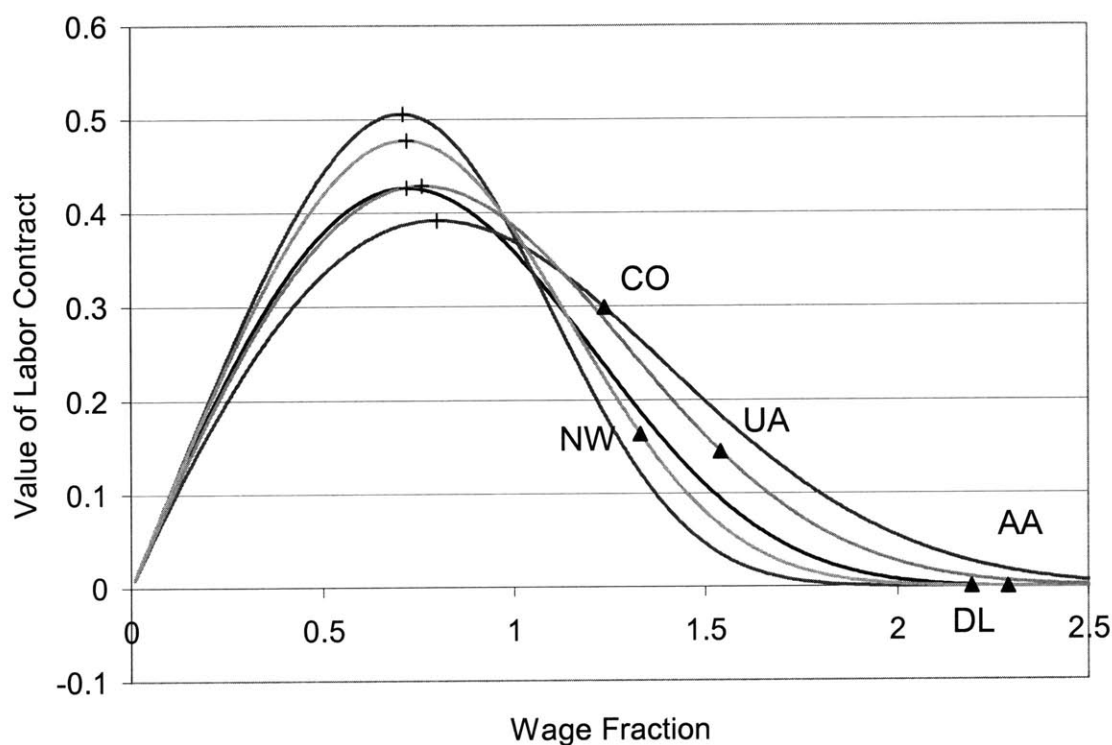


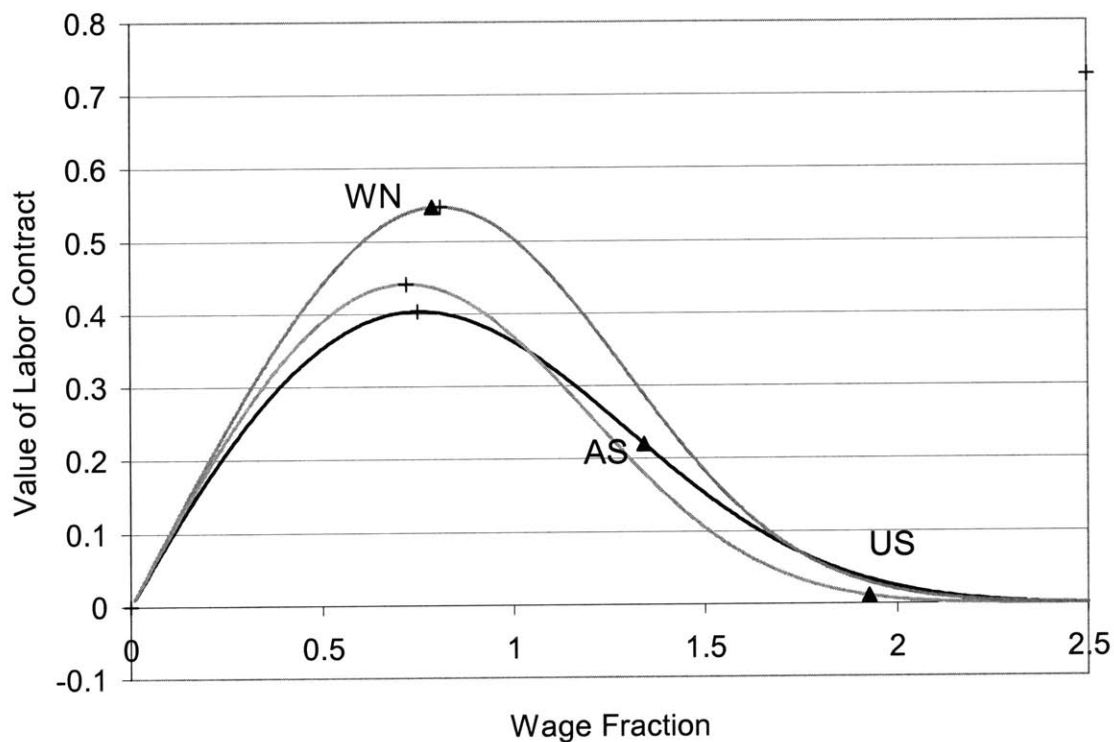
Figure 5-15: LCVCs for Top 5 US Major airlines in 2003

The LCVC's of the top five US major airlines, as well as their positions on their LCVC's for 2003, are shown in Figure 5-15. Recall that a *Wage Fraction* of 1.0 represents the point at which an airline earns the same profitability as risk-free treasury returns and the remaining revenue premium has been captured by labor. When an airline is unable to earn a return higher than the risk-free return, the attractiveness of the airline to investors diminishes, and its ability to borrow suffers. In other words, this situation indicates financial trouble. Based on the data from 2000 in Section 5.3, airlines with a *Wage*

*Fraction* of greater than 1.0 faced financial trouble shortly after September 11, 2001. Two years later in 2003, United Airlines, even under the protection of the bankruptcy court, was still operating at a *Wage Fraction* of almost 1.54. (Note that with bankruptcy related costs, UA's *Wage Fraction* was 2.2. By concentrating on the operating fundamentals of the airline and ignoring bankruptcy related costs, UA's *Wage Fraction* was reduced to 1.54) American Airlines narrowly averted the filing for bankruptcy, but the long-term prospects of the airline have appeared dim, as their *Wage Fraction* is still at a very high level of 2.29. (Note that American recorded an aircraft retirement related charge of 407 million dollars in 2003. If this charge is included, AA's *Wage Fraction* was 3.2) While this section is being edited in late October of 2004, Delta Airlines may be filing for bankruptcy protection within weeks. The *Wage Fraction* of Delta Airlines was 2.19 in the year 2003. In summary, the three largest airlines of the nation, namely AA, UA, and DL, have all been operating at a *Wage Fraction* much greater than 1 with labor contract values at close to zero. According to the labor contract value analysis, it is in the interest of the labor groups to reduce labor cost significantly in order to improve the value of their labor contracts. Similarly, Northwest Airlines has been operating at a *Wage Fraction* higher than 1, and their labor contract values have been much lower than optimum, and the same can be said for Continental Airlines. The labor contract value analysis indicates that the labor unions at all five Majors will benefit from a reduction in their labor cost.

As this section is being written, United Airlines is asking its labor unions for another round of salary cuts because the management has not been able to find other ways to emerge from bankruptcy given their current level of profitability. That is, without reducing their *Wage Fraction*, United Airlines have not been able to find investors to finance its emergence from bankruptcy since the airline does not have the ability to earn even risk-free returns. American Airlines is also considering ways to reduce labor cost such as asking for further labor concessions and adding seats to its aircraft. Delta is asking its pilots for cost concessions, but the management has also reported that the airline may still have to file for bankruptcy protection whether or not an agreement for a pay reduction will be achieved.

The right-most column in Table 5-13 shows the percentage of wage reduction required to maximize labor contract value. For the airline labor contract valuation analysis, labor cost is defined in terms of cost per available seat mile (ASM). The results suggest that in order to achieve maximum labor contract value, labor cost per ASM at the top three majors need to be reduced by 19 percent to 35 percent. This reduction can come from two forms: 1) a reduction in salary, and 2) an improvement in productivity. If the labor unions are able to help the airline significantly reduce its labor cost per ASM, then the labor unions will achieve a higher labor contract value.



**Figure 5-16: LCVCs for Next 3 US Major airlines in 2003**

The next three US Major airlines in 2003 are illustrated in Figure 5-16. The graph for TWA does not appear because, in 2003, the airline no longer exists. In 2003, America West Airlines operated at a wage fraction of 1.0. Due to the low historical profit and high historical volatility of the airline, its LCVC's peak would extend to a point beyond the right edge of the chart. In order to avoid confusion, the graph for America West Airlines has been omitted.

Alaska Airlines operated at a *Wage Fraction* higher than optimum in 2003. Its *Wage Fraction* was still significantly lower than those of the three top Majors. Even though the need of Alaska Airlines to reduce its *Wage Fraction* is not as urgent as the needs of the other airlines to do the same, the labor unions of Alaska Airlines can still benefit with a reduction in labor cost. Their peak contract value could be reached with an 18 percent reduction in labor cost per ASM.

Southwest Airlines in 2003 operated almost exactly at the peak labor contract value point. Any increase or decrease in *Wage Fraction* would have reduced its labor contract value. One alarming development in 2004 was that one of its labor groups negotiated a large increase in salaries. Since Southwest Airlines was already at the peak contract value point, any increase in salaries and therefore *Wage Fraction* could significantly reduce their labor contract value.

USAirways emerged from bankruptcy in the Spring of 2003, but the airline was soon forced back into bankruptcy in the fall of 2004. For 2003, USAirways operated at a wage fraction much greater than 1 with a labor contract value of 0. The labor groups can definitely benefit from a reduction in labor cost. Based on the *Wage Fraction* analysis, a 27 percent reduction in labor costs can increase USAirways' labor contract value to its peak. In October of 2004, USAirways' management negotiated with their Pilots' union for an 18 percent reduction in salaries. USAirways' management also asked the bankruptcy judge to grant a 23 percent reduction in salaries for all employees. In the end, the bankruptcy judge granted a 21 percent reduction in salaries. By improving productivity as well as trimming employee and retiree benefits, USAirways can operate at a point close to maximum labor contract value. This illustrates a counterintuitive point: a reduction in salaries actually improves the value of the labor contract.

In summary, with the exception of Southwest Airlines, all US Majors operated at a *Wage Fraction* greater than 1 in 2003. In fact, three of the Majors operated at such a high *Wage Fraction* that their labor contract value was close to zero. These Majors are either facing

bankruptcy, have been narrowly avoiding bankruptcy, or presently operating in bankruptcy. Their labor contract values could have been greatly improved if they were able to reduce their labor cost. Southwest Airlines operated at peak labor contract value in 2003, but a recent increase due to a newly negotiated contract could reduce the value of its labor contract. Individuals may find it counterintuitive that a decrease in salaries actually increases the value of a labor contract while an increase of salaries has the opposite effect. This confusion may be due to the fact that contracts are not tradable securities in the physical sense. A theoretical market value could, through the analysis presented here, be placed on the contract, but there is no trivial way for the labor contract values to be evaluated by individual members. In the future studies section, suggestions are made to place a value on labor contracts that is more easily grasped by individual members.

### 5.5.2 USAirways' 2<sup>nd</sup> Bankruptcy

After September 11, 2001, USAirways suffered financially and filed for bankruptcy in the fall of 2002. The airline was able to restructure its debts, reduce its labor cost, and present a business plan that attracted investors. USAirways successfully emerged from bankruptcy in the first quarter of 2003. However, in the fall of 2004, the operating performance of the airline had deteriorated again to such a degree that it filed for bankruptcy protection a second time.

In the business plan submitted to emerge from the first bankruptcy, projections of revenue and labor cost indicated that the airline would be operating at a *Wage Fraction* of 0.65. According to calculations made in Section 5.5.1, optimal *Wage Fraction* in 2003 was 0.72. If USAirways could have conducted business according to its business plan, then its labor groups would have had contracts near their peak values. The investors would then have received more than risk-free returns. The business plan turned out to be overly optimistic in its revenue and fuel cost projections, and the actual revenue of USAirways was short by about 15 percent, or about \$1 billion dollars. As a result of this revenue shortfall, the *Wage Fraction* of the airline increased to 1.93, and the value of its

contract reduced to 0. As the *Wage Fraction* increased over 1, the airline was earning less than risk-free returns, and the risk of bankruptcy increased significantly.

There are several possibilities for revenue shortfall for USAirways: 1) The expected economic recovery did not materialize; 2) Competitors aggressively entered markets of the airline, forcing a reduction in its yield; and 3) The airline could not convince its labor unions to agree to more wage cuts. In order to attract investors, however, the management had to inflate the revenue projections. As mentioned in Section 5.5.1, labor cost per ASM must be reduced further by 27 percent in order to achieve maximum labor contract value. Salary cuts are generally met with a great deal of resistance. However, for reasons mentioned above, the labor contract value analysis suggests that salary cuts, which reduce labor cost, would be in the best interest of those who wish to increase their labor contract value.

One measure to study the economic viability of an airline is its *Adjusted Revenue / Capital Employed*. *Adjusted Revenue* is the sum of earnings premium and labor salary premium. It captures the total economic rent a company is able to extract from its operations. *Capital Employed* is the amount of capital invested in order to generate profits for the airline. Here is a comparison of the values among the US Majors:

AA	9.86%
AS	13.61%
CO	14.86%
DL	11.85%
HP	12.47%
NW	27.26%
UA	11.07%
US	22.91%
WN	12.82%

**Table 5-14: *Adjusted Revenue / Capital Employed*, US Major airlines in 2003**

In 2003, USAirways was able to earn 22.91% in *Adjusted Revenue / Capital Employed*. With the exception of Northwest, it is higher than all the other Majors. This indicates that USAirways was able to extract a larger economic rent than most of the US Majors. For reference, according to Protz (working paper, 2004), Microsoft's *Adjusted Revenue / Capital Employed* was 37%. The fact that an airline with one of the largest economic rents among its peers had to file for bankruptcy indicates that the economic rent of

USAirways was not distributed rationally. As a result, both labor and equity are not achieving optimal value. This conclusion agrees with the labor contract value analysis.

### 5.5.3 Difficulties in Adopting the Labor Contract Value Analysis to Real World Data

The labor contract value analysis presented in this thesis is an economic model. Similar to the neoclassical microeconomics model, the labor contract value analysis should be treated as metaphors to the real world. This analysis can be used to study trends, but there are difficulties when applying the analysis directly to real world data. Since this chapter discusses applying the labor contract value analysis to the real world data from the airline industry, a discussion of problems and warnings is in order.

The main problem with applying this analysis to real world data has to do with forecasts and the selection of risk-free values. For example, to calculate *Wage Fraction* for a contract about to be signed, there are a number of variables that need to be estimated. *Wage Fraction* is defined as the *Wage Premium* /  $E(\text{Wage Premium} + \text{Profit Premium})$ . To calculate *Wage Premium*, the projected wage rate as well as the risk free wage rate needs to be calculated. The analyst needs to make assumptions for the risk free wage rate, which must include the cost of benefits for the risk-free job. The choice of risk-free wage and benefit rate has a large impact on the value of *Wage Fraction*. As for the denominator,  $E(\text{Wage Premium} + \text{Profit Premium})$ , the value is an expectation, which is essentially a forecast. In this research, historical values were used to make the forecast.

For the calculation of the location of the LCVC curve, predictions are needed for  $\sigma$ ,  $\rho$ , and  $S_{mkt}$ . Again all of these values are forecasts. Historical data were used to make the best educated guess.

No one can predict the future. Errors in the forecast could have an impact on the calculation for *Wage Fraction* as well as the calculation for the location of the LCVC curves. As mentioned earlier, in 2003, USAirways labor and management thought they reduced their labor cost to the point of peak labor contract value. However, their

forecasts for revenue were too high. As a result, their labor contract had a value of zero, and the airline had to file for bankruptcy protection a second time.

In summary, analysts need to be very careful when using the labor contract value formulas to study real world problems. Since the analysis requires forecasts, forecast values have to be carefully chosen. Risk-free values also have to be carefully chosen. When using the calculated results, the users of the formula need to understand that reality will be different from the forecast, and actual values will be different from predicted values. The results calculated using the labor contract value formula could be used as a guideline, but the users need to understand the possible shortfalls.

## 5.6 Airline Industry Case Study Summary

In this chapter, the labor contract valuation analysis is applied to the airline industry. The airline industry is a very challenging industry because profitability of the airlines has been historically volatile. Ever since deregulation in 1978, several airlines have failed. Legacy carriers also has been facing upstart low-cost challengers. Since labor cost is the largest cost component and since previous research has shown that airline labor groups have historically been able to extract large economic rent, airline management tend to look toward labor to improve profitability.

The labor contract valuation analysis from Chapter 3 is applied to the airline industry in this chapter. Historical data for each of the US Major carriers is used to construct their individual Labor Contract Value Curves (LCVC's). An analysis of the year 2000 showed that, with the exception of Southwest (WN), all remaining US Majors have been operating at a *Wage Fraction* higher than the optimal labor contract value point. Based on each of their historical revenue volatility, these airlines have been operating at a point where the possibility of bankruptcy is diminishing the value of their labor contracts.

In addition, *Wage Fraction* is a good indicator for the financial health of a company. A *Wage Fraction* of 1 indicates that all revenue premium is captured by labor, and a *Wage*



*Fraction* greater than 1 indicates that the airline is earning a return lower than the risk-free return rate. From the standpoint of investors, it is better for them at this point to invest their money in the risk-free Treasury Bond. In 2000, five of the ten US Majors were operating with a *Wage Fraction* value greater than 1. Four of these carriers faced financial troubles within the next two years.

The results of US Majors from 2000 highlight the following two points: 1) Most US Majors operate at a *Wage Fraction* higher than the optimal wage rate for labor contract value; labor can benefit in the form of a higher contract value if their pay is reduced.; and 2) A *Wage Fraction* greater than 1 is a good indicator for predicting financial trouble for an airline.

The shape of the LCVC is concave with a single and unique optimum point. Once the *Wage Fraction* is increased past the optimum *Wage Fraction* point, the value of the labor contract decreases significantly. An example of such a phenomenon is the labor contract value from 2000 to 2002 for United Airlines. In 2000, United Airlines appeared to be operating at a peak labor contract value. The pilot union of the airline requested and received a significant pay increase in the summer of 2000. As a result, the *Wage Fraction* of United Airlines increased past the optimum point, resulting in a large drop in labor contract value.

Next, the labor contract value analysis is performed on US Majors for the year 2003. With the exception of Southwest, the remaining US Majors all operated at a *Wage Fraction* higher than 1, indicating that those airlines were earning less than risk-free returns. The *Wage Fractions* of the airlines were much higher than their optimum *Wage Fractions*, and their labor contract values were poor. Most of these labor groups could have improved their contract value by taking a reduction in salaries and by improving their productivity. In fact, management at several airlines have been asking their labor groups to agree to significant pay reductions. According to the labor contract value analysis, if labor groups agree to the pay reductions and productivity improvements, they could significantly improve their labor contract values.

Finally, the ability of the US Majors to extract economic rent is compared using *Adjusted Revenue / Capital Employed* as the measure. The comparison indicates that no correlation between high *Adjusted Revenue / Capital Employed* and profitability exists. As an illustration, USAirways was able to extract more rent as a percentage of capital employed than all but one other US Major airline, yet USAirways still operated in bankruptcy eventually. This result indicates that, even though USAirways could extract economic rent, the profitability is not assured, and this rent was distributed among its stakeholders such that equity was left with less than risk-free returns. This analysis suggests that USAirways is nevertheless a fundamentally sound business with an ability to extract significant economic rent. The challenge of the airline management is to discover a more prudent distribution of economic rent among stakeholders.

## CHAPTER 6

# CONCLUSION AND FUTURE WORK

### 6.1 Conclusion

This thesis proposes an alternative approach to labor contract valuation using a version of portfolio theory. The value of a labor contract is the net present value of the expected payment stream to labor. This value is determined by the contractual wage rate, but it is also affected by the probability of the company going bankrupt or liquidating. As labor cost increases, the profitability of the company decreases. Initially, increasing salaries increase the value of the labor contract. However, at some point, the financial health of the company starts to suffer, and the probability of bankruptcy increases. The value of the labor contract reaches a peak point and steadily declines as the company nears bankruptcy. In this thesis, a model is developed to capture this phenomenon.

It is important to remind the readers that labor contract valuation differs from wage determination. Wage determination often involves subjective factors, such as negotiations between parties. Labor contract valuation on the other hand provides a quantitative value for the financial worth of the labor contract, given the specified wage rate and the company's risk of bankruptcy. The labor contract value determined by methodology presented in this thesis provides an objective and consistent measure. In this thesis, the focus was on labor contract valuation, not on wage determination after a negotiation process.

The thesis is structured around a set of four key questions. Here are the questions, each followed by a summarized answer.

1) How can a value be placed onto a labor contract as a function of wage rate?

Labor contracts are not tradable securities, and therefore it is difficult to place a financial value on the labor contract. However, since labor contracts specify periodic payments similar to those of bonds, it is possible to construct a duplicating bond of which the bond payments mirror labor contract salaries. By using financial tools, such as the portfolio theory, to evaluate the value of the duplicating bond, the value of the contract can be inferred.

In this thesis, labor contract value is presented in a normalized form. It is normalized by the expected *Adjusted Revenue* of the company. *Adjusted Revenue* is the sum of labor salary premium and company profit premium. *Adjusted Revenue* is also the total revenue minus the cost of goods sold (sunk cost), as well as risk-free return on capital employed and risk-free wage rate for labor. The formula for normalized labor contract value is the following:

$$\frac{w^*}{\mu} \cdot [N_0 + \rho \cdot N_1 \cdot S_{mkt}]$$

Where:

$w^*$  is the wage premium (rate) over risk-free labor wage

$\mu$  is the expected value for *Adjusted Revenue*

$N_0$  is the normal probability distribution

$N_1$  is the 1st moment of *Adjusted Revenue* distribution

$S_{mkt}$  is the Sharpe ratio of the market

$\rho$  is the correlation between market returns and *Adjusted Revenue*

By utilizing this formula, the labor contract value as a function of wage rate can be calculated.

2) How does the value of the labor contract change with increasing wage rate?

The motivation for developing this labor contract valuation model is to capture the interaction between increasing wage rate and increasing probability of bankruptcy. The

shape of the resulting Labor Contract Value Curve (LCVC) is concave with a single and unique maximum point.

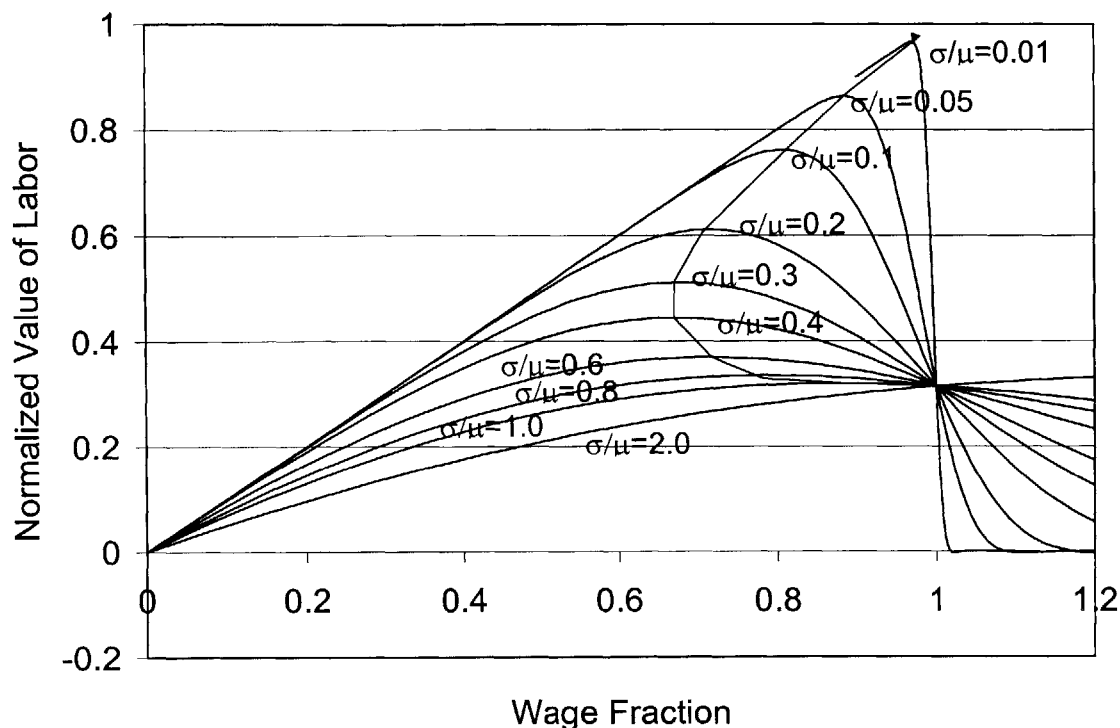


Figure 6-1: Normalized Labor Contract Value Curves (LCVCs) vs. Wage Fraction

*Wage Fraction* describes the division of *Adjusted Revenue* between equity and labor. A *Wage Fraction* value of 0 indicates that equity receives all *Adjusted Revenue* while labor receives risk-free salaries. A *Wage Fraction* value of 1 indicates that labor receives all *Adjusted Revenue* while equity receives risk-free returns. Increasing *Wage Fraction* is equivalent to increasing labor cost. As *Wage Fraction* increases from 0, the value of the labor contract increases linearly. As more *Adjusted Revenue* is transferred to labor, the probability of bankruptcy increases, and the value of the labor contract starts to deviate from the 45-degree tangent line. At the same revenue volatility level, the value of the labor contract with increasing *Wage Fraction* forms a Labor Contract Value Curve (LCVC). With increasing *Wage Fraction*, the labor contract value eventually reaches a peak, followed by a decline if the *Wage Fraction* is increased further. The concavity curve of the LCVC forms a single and unique maximum point. This maximum point signifies the point for which the labor contract value is at its highest, given the company's

revenue volatility. For labor, this point is the point where the net present value of their wage is at its highest, after adjusting for the probability of bankruptcy.

3) How can one compare the various labor contract values across different unions within the same company?

The approach used in this thesis is to treat contracts for individual labor groups as different securities and to use financial tools related to the CAPM – the Sharpe Ratio in this case – to make a comparison. At equilibrium, the Sharpe ratios of the two contracts are equal, meaning the risk-to-reward ratios of the two contracts are equal. Investors are indifferent between two securities if they are at equilibrium. Using the variable  $\delta$  to describe frictional loss for switching to the risk-free job, as a fraction of the risk-free wage for each labor group, and by applying the equilibrium condition, it is possible to make a comparison between unions using the following formula:

$$\therefore \frac{\frac{w_{2b} - 1}{w_{1b}}}{\frac{w_{2a} - 1}{w_{1a}}} = \frac{\delta_b}{\delta_a}$$

Where:

$w_1$  = risk free wage rate

$w_2$  = labor wage rate

$\delta$  = frictional loss fraction for labor if workers decide to seek the risk free alternative

a and b denote the two labor groups being compared.

The implications of this formula are as follows:

- a) If the original CAPM assumption of no friction is made, the formula is mathematically undefined. The assumption of no friction refers to the assumption that there is no cost to labor for switching to the risk-free job.
- b) Between two labor groups, the ratio of pay premium is equal to the ratio of the frictional loss fraction under equilibrium conditions. The pay premium is tied to the difficulty in finding the alternative risk-free job.

- c) Under equilibrium conditions, if the value of frictional loss fraction is assumed to be equal between two labor groups, ( $\delta_a = \delta_b$ ), then the wage premium percentage of the two groups are equal ( $w_{2b}/w_{1b} = w_{2a}/w_{1a}$ )
- d) When the value of frictional loss fraction is not equal between the two labor groups but the appropriate risk free wage can be chosen, it is possible to calculate the relative implied frictional loss fraction values.

4) When the labor contract value is at its peak, how will the time delay between profit and changes in pay affect the value of the labor contract?

In this thesis, a system dynamics model is constructed to study the effect of time delay between profit and changes in pay on the value of the labor contract. The motivation for this study is the case of United Airlines with their pilots' contract in 2000. Before the pilots' contract was negotiated in 2000, United Airlines had achieved several years of profitability while pilot salaries had remained stagnant. Pilots then received a large salary increase from the negotiations, just as the economy was about to enter a recession. Due to the delay between profitability and changes in salaries, peak profitability and peak labor cost became out of phase, likely contributing to the filing for bankruptcy protection by United Airlines.

The system dynamics model attempts to capture the effect of delay between profitability and pay increases. As this delay increases, the profitability of the airline, as well as labor contract value, becomes oscillatory. Simulation results suggest that longer delay between pay and profitability lead to larger oscillation amplitude. For labor groups, due to the concavity of the LCVC's, larger oscillation amplitude results in lower average value for the labor contract. Reducing the time delay between profit and changes in pay leads to higher average value for the labor contract.

The second part of this thesis focuses on applying the labor contract valuation analysis to the US airline industry. A labor contract value curve (LCVC) for each US major airline is created using historical *Adjusted Revenue* data from 1985 to 2000. In 2000, Southwest (WN) was the only airline with a *Wage Fraction* lower than its optimum *Wage Fraction*.

Delta (DL), Northwest (NW), Continental (CO), and America West (HP) operated at a *Wage Fraction* level that resulted in the value of their labor contracts being close to the maximum value. United (UA), USAirways (US), TWA (TW), Alaska (AS), and America West (HP) operated with *Wage Fraction* values greater than 1 in 2000, signifying that their equity holders were receiving a return lower than risk-free returns. By 2002, all but one of these airlines faced financial troubles. A *Wage Fraction* value higher than one in 2000 turns out to be a good predictor of financial risk.

The same labor contract valuation analysis is performed on US Major airlines for the year 2003. In this second analysis, historical data from 1985 to 2003 is used to construct the LCVC's. With the inclusion of 2001, 2002, and 2003 data, *Adjusted Revenue* volatility has increased for all airlines. Due to the economic recession as well as the aftermath of the events of September 11, 2001, US Majors showed worse financial performance in 2003 when compared to 2000. All US Majors operated at an increased *Wage Fraction* value. Southwest was operating at a point below the peak value in 2001, and by 2003 Southwest moved to the peak labor contract value. The rest of the US Majors moved further to the right, resulting in lower labor contract values. American (AA), Delta (DL), and USAirways (US) operated so far beyond the optimal that their labor contract values were zero in 2003. As this thesis is being written, USAirways has filed for bankruptcy, Delta pilots have just agreed to a large pay reduction, and American is looking for ways to reduce its cost.

Two of the US Majors were selected for a longitudinal study of their labor contract valuation. The airlines selected are United (UA) and Southwest (WN). Both airlines entered into long-term labor contracts with little or no pay increases for the duration of the contract. In the case of United Airlines, its labor contract value kept increasing, and at the end of the contract, United was at peak contract value. Instead of staying at the peak, its pilots negotiated a new contract with significant pay increases. Since United was already operating at the peak, any increase in *Wage Rate*, and as a result, *Wage Fraction*, led to a significant reduction in labor contract value. On the other hand, for Southwest, its labor contract valuation kept dropping during the contract period as



profitability of the company improved. In 2001 and 2002, pilots received increases in their salaries, and Southwest employees saw an improvement to the value of their labor contract. Southwest was able to remain at peak labor contract value in 2003. Southwest needs to be cautious with its labor cost, as any further increase in labor cost will lead to a significant reduction in labor contract value.

For the labor contract valuation analysis, it is important to point out that it is a model. When applying the model to real world data, it is important to recognize the limitations of the model. For example, the positions of the LCVC's are based on a forecast of the revenue volatility. For this analysis, historical data for revenue volatility is used to produce the forecast. No one can predict the future, and it is important to note the effect of a bad forecast could have on the analysis. A good example was USAirways' business plan when it emerged from bankruptcy in the spring of 2003. Based on its business plan projections, the airline would have been operating at near peak labor contract value. However, the revenue the management forecasted did not materialize, and as a result the airline operated at a *Wage Fraction* much higher than planned. By the fall of 2004, USAirways was forced to file for bankruptcy a second time.

The labor contract valuation framework is also used to gain some insight into the airline industry. *Adjusted Revenue* is the sum of labor premium and profit premium. The ratio of *Adjusted Revenue / Capital Employed* is used to compare the companies' ability to extract economic rent. The model results showed that even airlines in bankruptcy, such as USAirways, may still have ability to earn significant economic rent. The fact that USAirways is in bankruptcy even with a high value of *Adjusted Revenue / Capital Employed* raises the question of why the company is not more financially successful. The key lies in the fact that, even though the company can earn significant *Adjusted Revenue*, the share of this adjusted revenue that equity received was lower than the risk-free alternative.

Finally, the labor contract valuation analysis was used to study the percentage labor cost reduction in order to achieve maximum labor contract value, based on 2003 data. It is

interesting to note that Delta pilots agreed to a 32.5% pay reduction while the contract valuation analysis suggests a 35% pay reduction would lead to peak contract value. For USAirways, the contract valuation analysis suggests that a 27% pay reduction is needed to achieve peak contract value while the bankruptcy judge ruled for a 23% pay cut. While the percentages of pay reduction are not exact, it does indicate that the labor contract valuation analysis presented in this thesis can arrive at results that mirror real world situations.

## **6.2 Suggestions for Future Work**

In this section, three suggestions are made for future work.

1) In Chapter 3, the CAPM is used to calculate the value of labor contracts, and the Sharpe ratio is used to compare pay distribution between labor groups. Since the CAPM was originally developed to study investment returns, one natural extension is to use the CAPM to study the returns for airline equity holders, and use the Sharpe ratio or other methods to compare pay distribution between labor and ownership. This thesis focuses on the side of labor, taking into consideration the probability that the company may not operate. It would be interesting to perform a similar analysis to study the return on investment for equity holders, taking into consideration the probability that the company may not operate. This thesis studied revenue distribution among labor groups, and it would also be interesting to perform a similar analysis to apply the equilibrium analysis for comparison between the ownership and labor. The result of such a study could improve the understanding of rent distribution among stakeholders.

2) Another area of possible future research is in use of the system dynamics model for studying the relationship between profit, pay, and productivity. One future direction of work could be to incorporate historical data from US airlines. Simulation results presented in this thesis are based on hypothetical inputs, and it might be interesting to incorporate historical airline data into this simulation model. Also, in this thesis, it is

suggested that one way to maintain high labor contract value is to tie salaries to the *Adjusted Revenue* of a company. As an extension to the system dynamics model, a revenue sharing scheme could be modeled using historical data. A theoretical optimum contract could be one that has a fixed component tied to the risk-free wage with a variable component tied to the *Adjusted Revenue*. The system dynamics model could be extended to study if such a revenue sharing contract could improve labor contract value.

3) Since labor contracts are not tradable, it is impossible for management and labor to realize the value of the labor contracts. As a consequence, union representatives have no way of knowing the impacts of their wage demands on the labor contract value. One possible solution is for labor unions to seek insurance for their salaries. Insurance underwriters would calculate the risk of labor not receiving their contractual wage, and this risk would be reflected in the insurance premium. The amount of the insurance premium would allow union negotiators to understand the impact of their wage demands.

Labor cost is the largest cost component in the production of the airline. This researcher hopes that the analysis presented here could be used by both labor and management to better understand labor contract valuation. This researcher also hopes that other researchers will find the three research questions discussed here interesting and take on the challenge of studying these questions. And finally, this researcher hopes that the results presented in this thesis, as well as studies by future researchers, can help the US airline industry become a financially healthier industry from which all consumers and stakeholders could benefit.



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## Appendix I: Value of Labor Contracts Formula Derivation

### Part I: Standard formulation for the Capital Asset Pricing Model (CAPM)

Standard CAPM formula: (Investments by Bodie, Kane, and Marcus, 4<sup>th</sup> Edition, 1999)

$$E[r] = r_{rf} + \beta \cdot (E[r_{mkt}] - r_{rf}) \quad (1)$$

Where:

$E[r]$  = Expected return on investment

$E[r_{mkt}]$  = Expected market return

$r_{rf}$  = risk-free rate of return

$$\beta = \frac{\text{cov}[r, r_{mkt}]}{\text{var}[r_{mkt}]}$$

### Part II: Calculation of the parameters in the CAPM formula:

The following are the standard definitions of expected value and variance:

Definition of Expected Value:

$$E[x] = \bar{x} = \int_{-\infty}^{\infty} x \cdot p(x) dx \quad (2)$$

$$E[y] = \bar{y} = \int_{-\infty}^{\infty} y \cdot p(y) dy \quad (3)$$

Definition of Variance:

$$\sigma_x^2 = \int_{-\infty}^{\infty} (x - \bar{x})^2 \cdot p(x) dx \quad (4)$$

$$\sigma_y^2 = \int_{-\infty}^{\infty} (y - \bar{y})^2 \cdot p(y) dy \quad (5)$$

The formula for variance can be written as:

$$\sigma_x^2 = E[(x - E[x])^2] = E[x^2] - E^2[x] \quad (6)$$

And the formula for covariance can be written as:

$$COV[x, y] = E[(x - E[x])(y - \bar{y})] = E[x \cdot y] - E[x] \cdot E[y] \quad (7)$$

Now consider the labor specific case,

Let

$$\begin{aligned} w &= w^*, x \geq x^* \\ w &= 0, x < x^* \end{aligned} \quad (8)$$

Note that for labor,  $w$  is wage premium (net present value of the wage premium expected for the time period in the CAPM model), and  $y$  is *adjusted revenue*. Please see Chapter 3 for a detailed explanation for *adjusted revenue*. In summary, *adjusted revenue* for each company is the sum of labor premium and operating profit premium. *Adjusted revenue* can be considered the return premiums of labor and ownership combined.

The expected value and variance for  $w$ , from formulas (2) and (6), are:

$$E[w] = \int_{x^*}^{\infty} p(x) \cdot w^* dx \quad (9)$$

$$E[(w - E[w])^2] = E[w^2] - E^2[w] = \int_{x^*}^{\infty} (w^*)^2 p(x) dx - \left( \int_{x^*}^{\infty} w^* p(x) dx \right)^2 \quad (10)$$

And the covariance,  $COV[w, y]$ , from formulas (4) and (7), is:

$$\begin{aligned} E[(w - E[w])(y - \bar{y})] &= E[w \cdot y] - E[w] \cdot E[y] \\ &= E[w \cdot (y - \bar{y})] - E[E[w] \cdot (y - \bar{y})] \\ &= E[w \cdot (y - \bar{y})] - 0 \cdot E[w] \\ &= E[w \cdot (y - \bar{y})] \\ &= \int_{y=-\infty}^{\infty} \int_{x=x^*}^{\infty} (w^*)(y - \bar{y}) \cdot \rho(x, y) dx dy \\ \therefore E[(w - E[w])(y - \bar{y})] &= \int_{y=-\infty}^{\infty} \int_{x=x^*}^{\infty} (w^*)(y - \bar{y}) \cdot \rho(x, y) dx dy \quad (11) \end{aligned}$$

Now consider the calculation of the value of labor, formula (9):

$$E[w] = \int_{x^*}^{\infty} p(x) \cdot w^* dx = P(x^*) \cdot w^*$$

Since the Capital Asset Pricing Model assumes that there is a mean and variance to the distribution of the returns,

$$\begin{aligned} P(x^*) &= \int_{x=x^*}^{\infty} \int_{y=-\infty}^{\infty} p(x, y) dy dx \\ &= \int_{x=x^*}^{\infty} \frac{1}{\sqrt{2\pi}} \frac{1}{\sigma_x} e^{-\frac{1}{2}(\frac{x-\bar{x}}{\sigma_x})^2} dx \\ &= \int_{-\infty}^{z^*} \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}z^2} dz \\ &= N_0(z^*) \end{aligned}$$

Note that  $z = \frac{\bar{x} - x}{\sigma_x}$

$$\therefore E[w] = P(x^*) \cdot w^* = N_0(z^*) \cdot w^* = N_0(z^*) \cdot \frac{w^*}{\sigma_x} \cdot \sigma_x \quad (12)$$

This is the expected value of labor.

Next, calculate the variance of labor:

$$\begin{aligned} E[(w - E[w])^2] &= \int_{x^*}^{\infty} p(x) \cdot (w^*)^2 dx - E^2[w] \\ &= (w^*)^2 \cdot P(x^*) - P^2(x^*) \cdot (w^*)^2 \\ &= (w^*)^2 \cdot P(x^*) \cdot (1 - P(x^*)) \\ &= (w^*)^2 \cdot N_0(z^*) (1 - N_0(z^*)) \quad (13) \end{aligned}$$

Finally, calculate the covariance between labor and the overall market:

$$\begin{aligned}
COV[w, y] &= E[(w - E[w]) \cdot (y - \bar{y})] = \int_{y=-\infty}^{\infty} \int_{x=x^*}^{\infty} (w^*) \cdot (y - \bar{y}) \cdot p(x, y) \cdot dx dy \\
&= \int_{x=x^*}^{\infty} (w^*) \cdot \rho \cdot (x - \bar{x}) \cdot \frac{\sigma_y}{\sigma_x} \cdot \frac{1}{\sqrt{2\pi}} \cdot \frac{1}{\sigma_x} e^{-\frac{1}{2} \left( \frac{x - \bar{x}}{\sigma_x} \right)^2} dx \\
&= -\sigma_x \cdot \sigma_y \cdot \rho \cdot \frac{w^*}{\sigma_x} \cdot N_1(z^*) \\
&= -\sigma_y \cdot \rho \cdot w^* \cdot N_1(z^*) \quad (14)
\end{aligned}$$

Recall from formula (12),  $z = \frac{\bar{x} - x}{\sigma_x}$ ,

Also note that

$$w^* \cdot N_1 \cdot \rho = \frac{COV[w, y]}{\sigma_y} = COV[w, \frac{y}{\sigma_y}] \quad (15)$$

Part III: Substituting labor specific parameters into the CAPM formula:

$$CAPM: E[r] = r_{rf} + \beta \cdot (E[r_{mkt}] - r_{rf})$$

The payout structure for labor is:

$\Pi = w$ , with probability  $p$

$\Pi = w_{rf}$ , with probability  $1-p$

so

$$\Pi = w_{rf} + \begin{cases} w - w_{rf} \\ 0 \end{cases}$$

Let  $L$ =value of labor contract, then

$$E[r] = \frac{E[\Pi]}{L} = \frac{w_{rf}}{L} + \frac{E[w]}{L} \quad (16)$$

also let

$$r = \frac{\Pi}{L} = \frac{1}{L}(w_{rf} + w) \quad (17)$$

$$\begin{aligned} \beta &= \frac{COV[r, r_{mkt}]}{VAR[r_{mkt}]} = \frac{COV[\frac{\Pi}{L}, y]}{VAR[y]} = \frac{1}{L} \frac{COV[\Pi, y]}{VAR[y]} \\ &= \frac{1}{L} \frac{E[(w_{rf} + w - w_{rf} - E[w]) \cdot (y - \bar{y})]}{VAR[y]} \\ &= \frac{1}{L} \frac{E[(w - E[w]) \cdot (y - \bar{y})]}{\sigma_y^2} \quad (18) \end{aligned}$$

substitute  $E[r]$  (16) and  $\beta$  (18) into CAPM, multiply by  $L$ , and reorder:

$$(L - \frac{w_{rf}}{r_{rf}}) \cdot r_{rf} = E[w] - \frac{E[(w - E[w]) \cdot (y - \bar{y})]}{\sigma_y^2} \cdot (\bar{y} - r_{rf}) \quad (19)$$

Since salaries are usually distributed after the work is performed, divide the wage term by the risk-free rate to calculate the Net Present Value (NPV) of the wage:

Let  $L_{rf} = \frac{w_{rf}}{r_{rf}}$  (20),  $L_{rf}$  is the NPV of the risk free wage:

$$\begin{aligned} (L - L_{rf}) \cdot r_{rf} &= E[w] - \frac{E[(w - E[w]) \cdot (y - \bar{y})]}{\sigma_y^2} \cdot (\bar{y} - r_{rf}) \\ &= N_0 \cdot w^* + \frac{\sigma_x \sigma_y \rho \left[ \frac{w^*}{\sigma_x} \right] \cdot N_1}{\sigma_y^2} \cdot (\bar{y} - r_{rf}) \\ &= N_0 \cdot w^* + \rho \cdot w^* \cdot N_1 \cdot \frac{(\bar{y} - r_{rf})}{\sigma_y} \end{aligned}$$

Note that  $\frac{(\bar{y} - r_{rf})}{\sigma_y} = S_{mkt}$ ,

$$\begin{aligned} \therefore (L - L_{rf}) \cdot r_{rf} &= w^* \cdot [N_0 + \rho \cdot N_1 \cdot S_{mkt}] \\ &= w^* \cdot N_0 + w^* \rho \cdot N_1 \cdot S_{mkt} \quad (21) \end{aligned}$$

By substituting formulas (12) and (15), the value of labor can be simplified to the following formula:

$$(L - L_{rf}) \cdot r_{rf} = E[w] + S_{mkt} \cdot COV(w, \frac{y}{\sigma_y}) \quad (22)$$

Part IV: Non-dimensional value of labor:

Divide (21) by  $\mu$ ;

$$\frac{(L - L_{rf}) \cdot r_{rf}}{\mu} = \frac{w^*}{\mu} \cdot [N_0 + \rho \cdot N_1 \cdot S_{mkt}]$$

$$\therefore \frac{(L - L_{rf})}{\left(\frac{\mu}{r_{rf}}\right)} = \frac{w^*}{\mu} \cdot [N_0 + \rho \cdot N_1 \cdot S_{mkt}]$$

Or

$$\therefore \frac{(L - L_{rf})}{\left(\frac{\mu}{r_{rf}}\right)} = \frac{w^*}{\mu} \cdot N_0 + \frac{w^*}{\mu} \cdot \rho \cdot N_1 \cdot S_{mkt} \quad (23)$$

Formula 23 is the formula presented in the non-dimensional value of labor graphs.

Since  $\frac{w^*}{\mu}$  is *wage fraction*, Formula 23 can also be written as:



$$\therefore \frac{(L - L_{rf})}{\left(\frac{\mu}{r_{rf}}\right)} = WageFraction \cdot [N_0 + \rho \cdot N_1 \cdot S_{mkt}] \quad (24)$$

Now recall that  $z = \frac{\bar{x} - x}{\sigma_x}$ ; in this case, wage, or  $w$ , replaces  $x$ , so  $z^* = \frac{\mu - w^*}{\sigma_w}$  (25)

Rearrange (25) gives:

$$w^* = \mu - z^* \sigma_w \quad (26)$$

Substitute (26) into the formula for wage fraction:

$$WageFraction = \frac{w^*}{\mu} = 1 - z^* \frac{\sigma_w}{\mu} \quad (27)$$